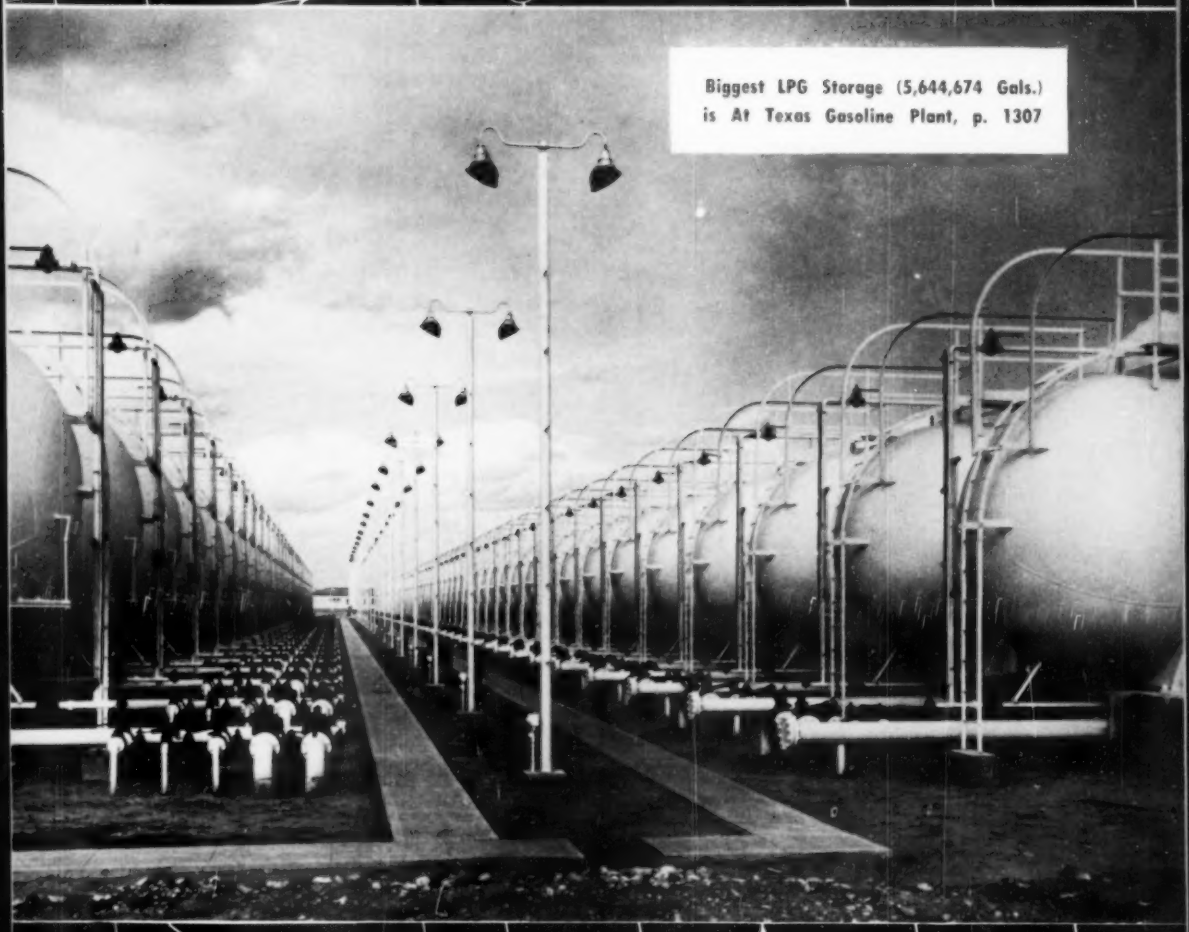
DECEMBER, 1950
VOL. 5, NO. 12

PETROLEUM PROCESSING



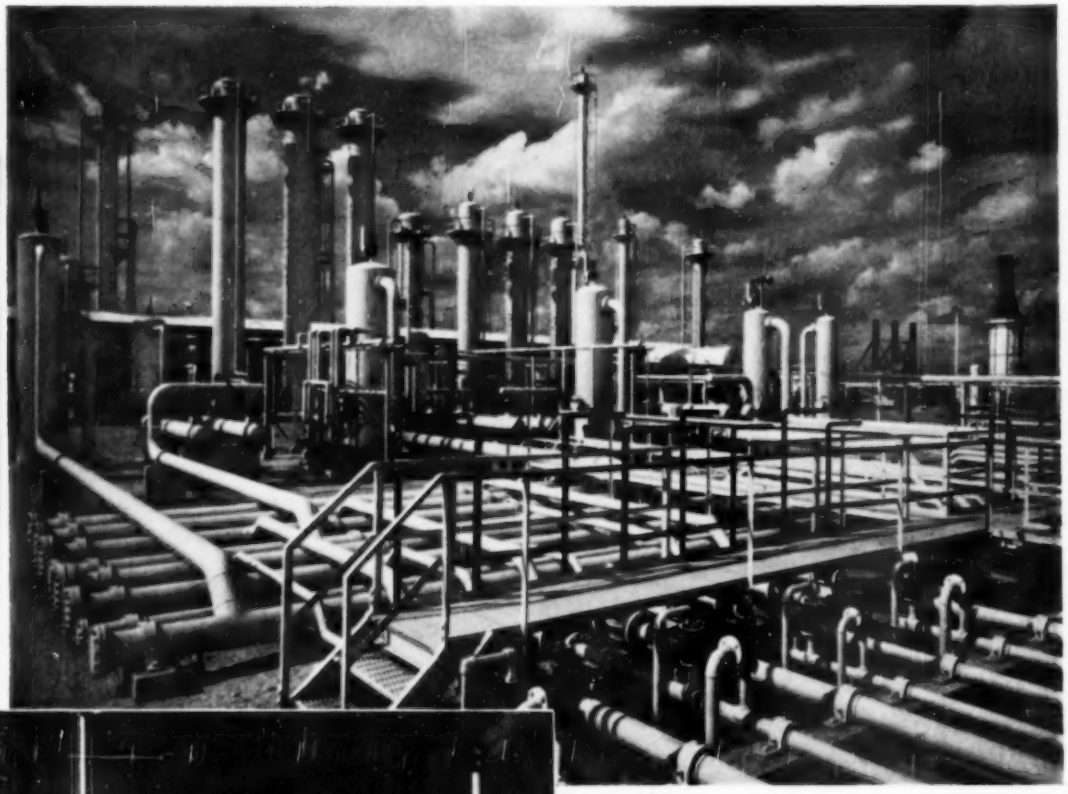
Biggest LPG Storage (5,644,674 Gals.) is At Texas Gasoline Plant, p. 1307

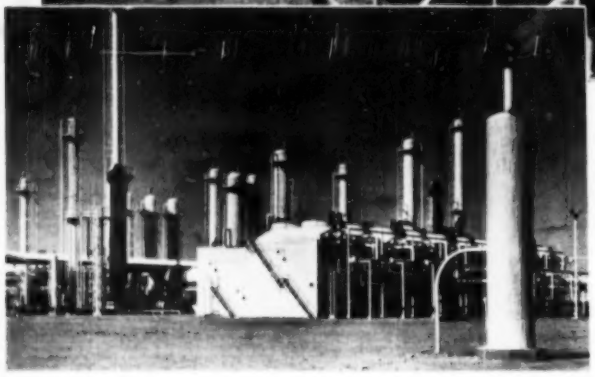
13 in 49

The Benedum Plant

in the Benedum Field, Upton County, West Texas

Designed and constructed for PLYMOUTH OIL COMPANY, the plant pictured below is one of 13 plants completed by HUDSON in 1949. Of these 13 major projects, 8 were for clients for whom HUDSON had previously engineered and constructed plants—good evidence of the satisfaction of Owners and Operators of HUDSON built plants.





HUDSON air-cooled sections are used extensively in the Benedum Plant to minimize water consumption in this arid, water-scarce area.

HUDSON

ENGINEERING CORPORATION

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GAS COMPRESSOR STATIONS — CYCLING PLANTS — GAS DEHYDRATION PLANTS — NATURAL GASOLINE PLANTS — FRACTIONATION UNITS — CRUDE TOPPING UNITS — PRESSURE MAINTENANCE PLANTS — HYDROGEN SULPHIDE REMOVAL PLANTS — ATMOSPHERIC AND VACUUM DISTILLATION UNITS

Value of "lead" to refiners increased by modern engine design

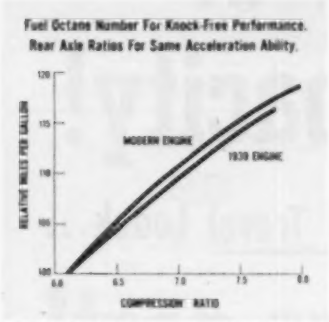


CHART 1. Effect of progress in engine design on increase in fuel economy from higher compression ratios.

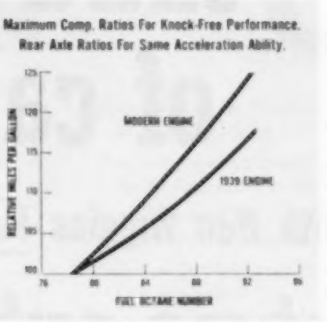

Maximum Comp. Ratios For Knock-Free Performance.
Rear Axle Ratios For Same Acceleration Ability.
MODERN ENGINE
1939 ENGINE
RELATIVE MILES PER GALLON
FUEL OCTANE NUMBER

CHART 2. Effect of progress in engine design on increase in fuel economy from gasolines of better antiknock quality.

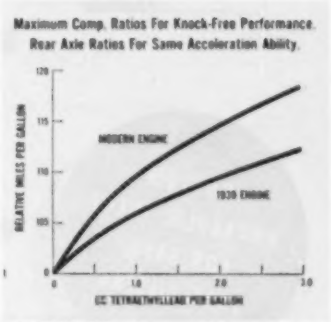

Maximum Comp. Ratios For Knock-Free Performance.
Rear Axle Ratios For Same Acceleration Ability.
MODERN ENGINE
1939 ENGINE
RELATIVE MILES PER GALLON
CC TETRAETHYLLEAD PER GALLON

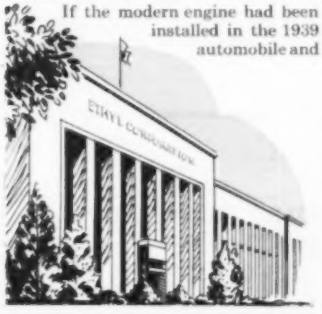
CHART 3. Effect of progress in engine design on increase in fuel economy from tetraethyllead added to average base for premium gasoline.

Today's engines of advanced design utilize fuel antiknock quality more effectively . . . enable tetraethyllead to deliver more miles per gallon to motorists.

Comparison of a 1939 engine and modern engine, both representative of the best design for each period, indicates that more effective use of octane numbers is being made today. In the Ethyl Laboratories extensive dynamometer data relating to engine performance and fuel antiknock quality were obtained on both engines. Later the engines were installed in cars so that complete data could be obtained on the road.

Modern design gives 10% Improvement

When fuel of 78.3 octane number with proper compression ratio was used, the maximum brake mean effective pressure at 1000 revolutions was 104.3 lb. per square inch for the 1939 engine and 114.5 for the modern engine. Gasoline consumed per hour in the development of one horsepower at 1000 RPM and a throttle setting corresponding to a level-road speed of 20 MPH was 1.08 lb. for the 1939 engine and 0.91 lb. for the modern engine.



If the modern engine had been installed in the 1939 automobile and had been operated at the proper compression ratio for 78.3 octane gasoline, the acceleration and hill-climbing performance of the car would have been about 10% better and gasoline economy improved at least 10%.

Obviously the modern engine makes more efficient use of gasolines having antiknock quality typical of the late prewar period.

Better use of TEL at higher compression ratios

The charts compare the improvement in gasoline economy of the two engines as the compression ratio was increased to take advantage of the better fuels marketed since 1939.

Chart 1 shows the relative fuel economy as the compression ratio was increased from 6.1. The actual fuel economy of the modern engine at 6.1 compression ratio was better than that of the 1939 engine, as previously explained; however, as two different automobiles were used, the road fuel economy of each engine at 6.1 compression ratio has been arbitrarily established at a relative value of 100. The divergence of the curves indicates that the modern engine had about 11% greater rate of improvement in gasoline mileage as compression ratio was increased.

In the utilization of "chemical octane numbers," the modern engine is far superior. In addition to the aforementioned larger gain in economy *per compression ratio*, the modern engine permitted a considerably greater increase in compression ratio *per octane number*. The combined effect of these two advantages is indicated in Chart 2 which shows the relative percentage increase in gasoline economy of the same two engines on the road when the compression ratio was increased from that permissible with fuel of 78.3 octane number to that suitable for 92.8 octane fuel, at constant acceleration ability. The improvement for the 1939 engine was about 18%, whereas that for the modern engine was 25%, or 39% greater.

The more effective utilization of fuel antiknock quality by modern engines of advanced design enables tetraethyllead to deliver far greater benefits. This is illustrated in Chart 3, in which road-test data show that 3.0 cc tetraethyllead added to an average base stock for 1949 premium gasoline permits an increase in the compression ratio of the 1939 car which yields 12.3% gain in fuel economy. In the modern engine, the same amount of tetraethyllead yields 18.4% increase in fuel economy. Thus, in the modern engine, tetraethyllead is worth about 50% more in terms of gasoline economy.

Over 400 specialists working full time on fuel and engine developments

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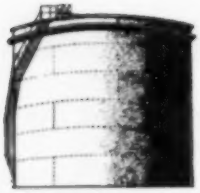

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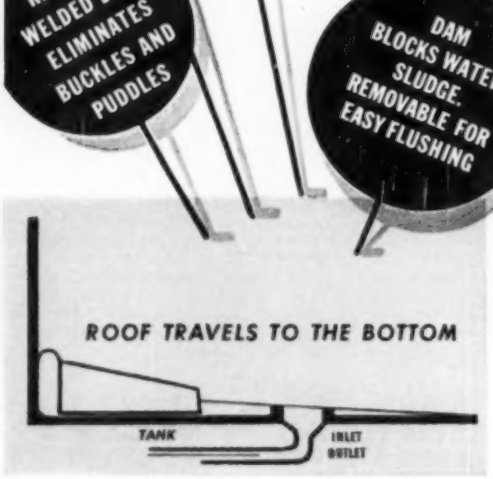

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VOL. 5, NO. 12 DECEMBER, 1950

Contents

FEATURE ARTICLES

What's Ahead for Petroleum in the Energy Markets?, *by Chester F. Smith* 1297

How Self-Adjusting Skimmers Improve Operation of Waste Separators, *by W. O. Small* 1300

Crankcase Explosions—Their Causes and Practical Remedies, *from a report by F. V. Cook* 1304

Gasoline Plant's Storage Holds Over 140 Days LPG Production 1307

Water Gas from Methane, *by Peter W. Sherwood* 1308

How Dual Installations Checked the Accuracy of Orifice Meters, *by L. V. Cunningham, Jr.* 1312

Q and A on Instrumentation, *from an on-the-spot wire recording of the Symposium on Instrumentation for the Process Industries* 1318

Natural Gasoline—Today's Equipment Is Tailored to Gasoline Plant's Needs, *from reports presented at the 25th Annual meeting California Natural Gasoline Association* 1320

DEPARTMENTS

What's Happening! 1259

Tomorrow in Petroleum Technology 1263

Plant Practices, Practical Tips and Ideas 1325

Laboratory Practices 1329

Processing Patents, *by Peter J. Gaylor* 1331

Equipment Patent Review 1339

News of Manufacturers—Suppliers—Engineering Firms 1344

Gasoline and Cycling Plant Operation, *by Dave Thornton* 1350

Refining Trends—Current Statistics 1353

Advertisers' Index 1356

What's New! Equipment, Material, Processes, Literature 1357

Meetings for the Oil Man 1367

Personals 1368

Editorial Viewpoints 1372

Other Platt Petroleum Publications

PLATT'S OILGRAM NEWS
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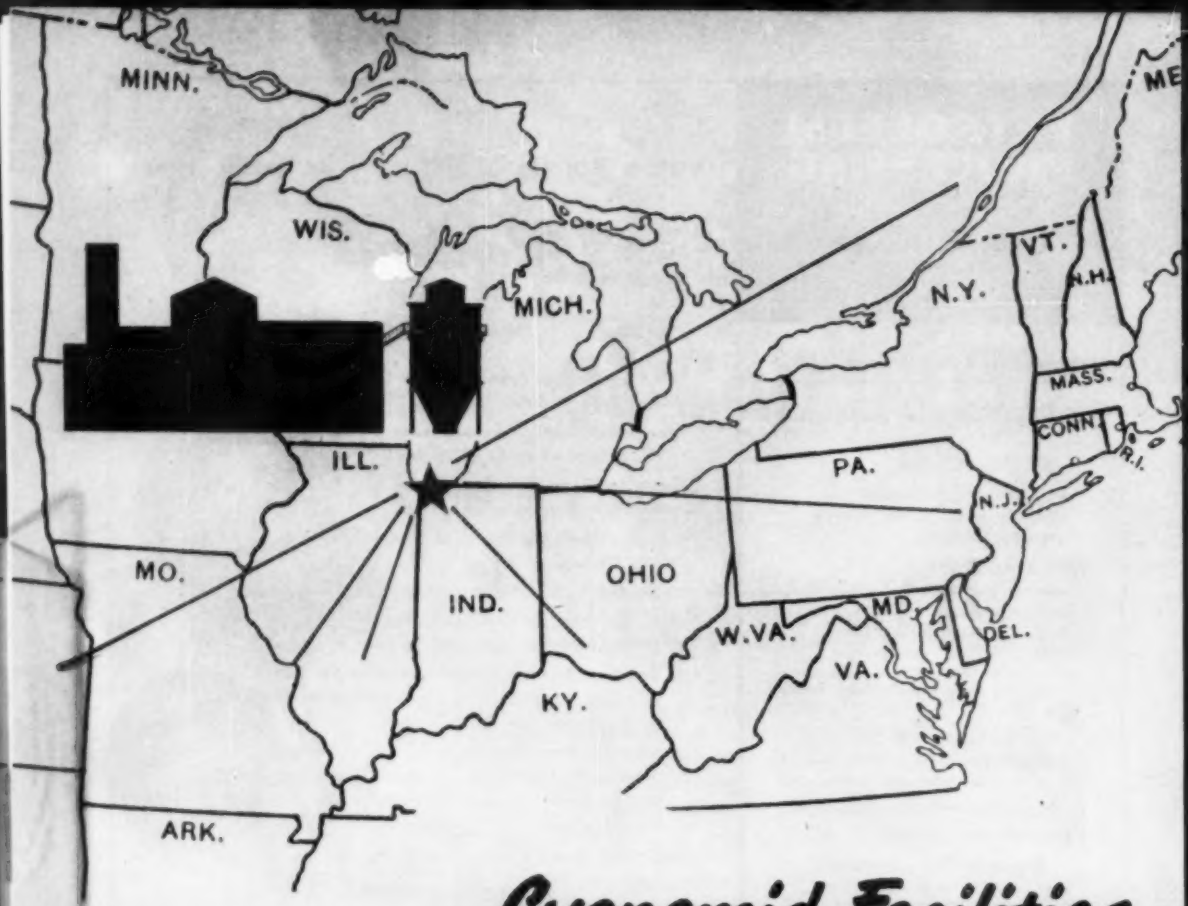

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serving the West and Southwest

Now under construction, Cyanamid's new plant at Michigan City, Indiana, is scheduled for completion in 1951. When operating at capacity, it will greatly increase the company's production of AEROCAT® Microspheroidal Synthetic Fluid Cracking Catalyst. The new plant will serve refineries on the Eastern seaboard and in the Middle-West, as well as refineries in Canada . . . supplementing Cyanamid's facilities at Ft. Worth which supply MS and ground catalyst to the Southwest and West.

Cyanamid's Performance Record

1942—Cyanamid starts production of synthetic fluid cracking catalysts at Ft. Worth to help refiners meet the demand for high octane fuel.

1946—Cyanamid expands Ft. Worth plant.

1946—Cyanamid becomes the *first* company to manufacture microspheroidal cracking catalysts on a commercial scale.

1948—Cyanamid expands production of MS catalyst at Ft. Worth in anticipation of growing demands.

1950—Cyanamid starts construction on new MS catalyst plant at Michigan City as refining demands continue to grow.

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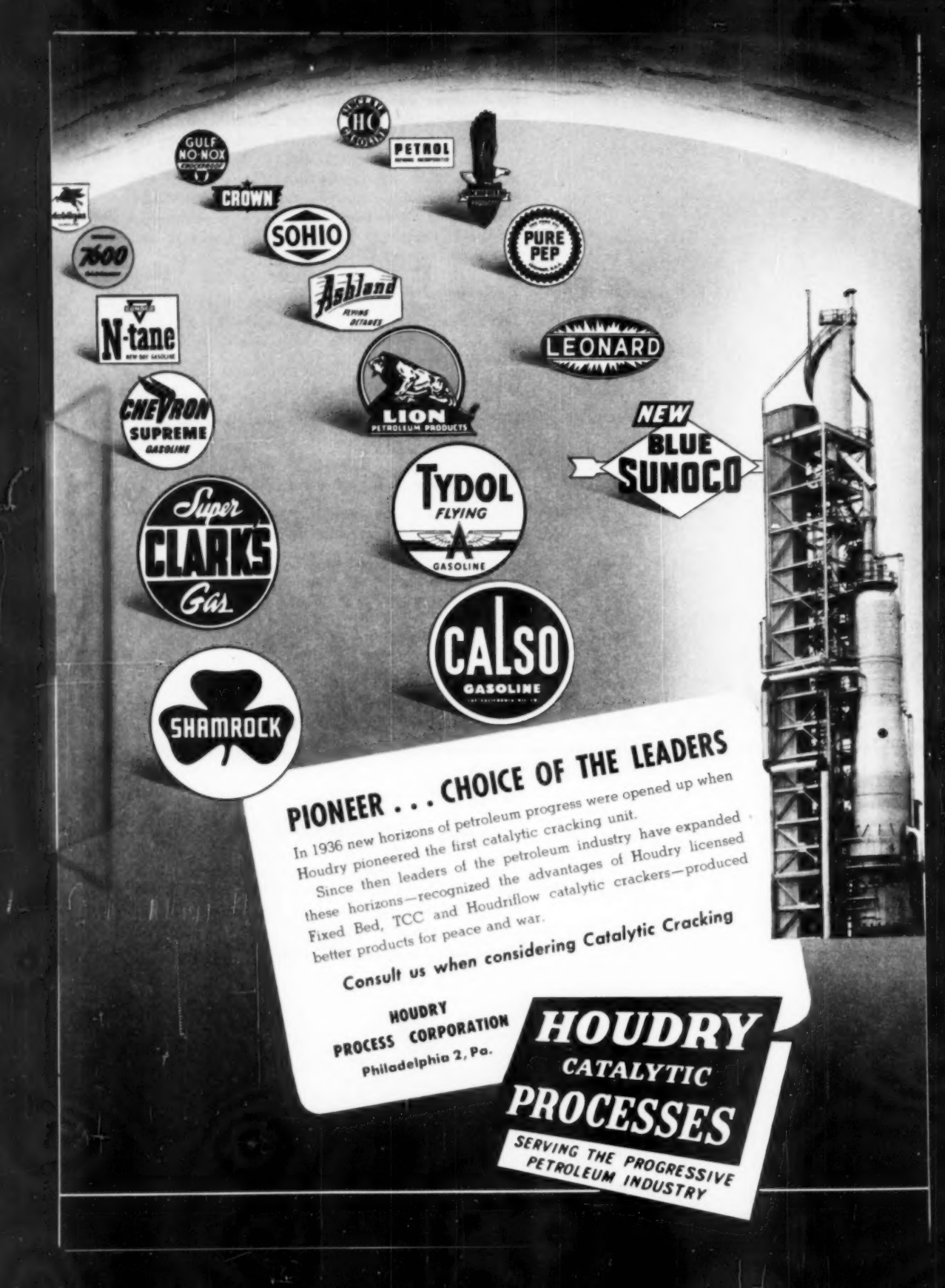
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WHAT'S HAPPENING

Current News Summarized For Oil Men

EXPANSION

Shell Oil Co. will install two of the largest Platforming units yet designed—15,000 b/d each. One will be put in at its Wood River, Ill., refinery, and the other at its Houston plant. Universal Oil Products will handle engineering and design, with construction by Procon, Inc. Completion is scheduled for Oct. 1, 1951.

Taylor Refining Co. has started construction of a 4,000 b/d Platforming unit at its Port Isabel, Tex. refinery with company crew. Universal Oil Products Co. is furnishing engineering designs. Completion is scheduled for next summer.

Derby Oil Co. has authorized construction within next 11 months of a 7,500 b/d Thermofor cracking unit and UOP catalytic polymerization and gas concentration plants at its Wichita, Kans. refinery, increasing crude throughput to 15,000 b/d from present 10,000 b/d rating. To cost approximately $2 million, basic process designs will be furnished by Socony-Vacuum Oil Co., Universal Oil Products Co. and the Fluor Corp., the latter also handling engineering and construction.

Continental Oil Co. has awarded contract to E. B. Badger & Sons to increase plant capacity at Lake Charles, La. to 25,000 b/d from present 11,000 b/d, including Thermofor catalytic cracking (see What's Happening for October, p. 1019).

Standard Oil Co. (Ind.) will increase capacity of its 10,400 b/d Neodesha, Kan. refinery by 9300 b/d. Existing crude distillation, coking and re-running facilities will be revamped, plus new tankage, utilities and facilities for improving product quality. Engineering work has commenced and construction will begin soon; completion is expected early in 1952. Cracking capacity will be increased later, probably by catalytic cracking.

Phillips Petroleum Co. is preparing to build a cycling plant of undisclosed size in the Chocolate Bayou field, south of Houston near Alvin, reportedly to cost $5 million. Brown & Root, Inc., are contractors.

Atlantic Refining Co. will put about $55 million into refining facilities in next five years. A new 40,000 b/d refinery, at a location yet to be determined, is among projected facilities.

PETROCHEMICALS

Jefferson Chemical Co. has announced plans for an ethanolamine synthesis unit at its Port Neches, Texas, plant. New facilities, to be completed in second quarter of 1951, will add mono-, di-, and triethanolamines to present line of oxy-hydrocarbons now derived by Jefferson from ethylene oxide. C. F. Braun is contractor.

Atlantic Refining Co. is expanding facilities for manufacturing synthetic detergents at both its Philadelphia and Port Arthur, Texas, refineries at an estimated cost of between 3 and 4 million dollars. The new facilities are planned to increase the output of alkyl aryl sulfonates as well as to manufacture new products.

• • •

INDUSTRIAL MOBILIZATION

Bruce K. Brown was sworn into office as Deputy Petroleum Administrator for Defense Nov. 22, one day after President Truman signed a long-awaited executive order authorizing the hiring of industry officials, without pay from the government, to hold key staff posts in mobilization agencies. Brown is president of Pan-Am Southern Corp., and for some time has served as chairman of the Military Petroleum Advisory Board.

Military Petroleum Advisory Board's committees will be incorporated and commissioned as committees of Petroleum Administration for Defense within a few months, according to Deputy PAD Bruce Brown. He said that the work of the committees and the committee membership will continue as in the past, except that the committees will become a part of PAD.

Added to list of "critical occupations"—stillmen and treaters in the petroleum processing field, according to a revision issued early last month by Labor Department, which prepared the list several months ago as a guide for the Defense Department in expanding the Armed Forces.

Aluminum for non-defense uses has been cut 35% by NPA Order M-7, issued Nov. 13. Effective Jan. 1 manufacturers of aluminum products may not use for non-defense purposes more than 65% of the average quarterly use of aluminum during the first six

Information on these pages is obtained through the nation-wide news coverage service of PLATT'S OILGRAM NEWS

months of this year. This order represents the first direct curb on civilian consumption since the outbreak of Korean hostilities.

Distribution of steel allocations to all phases of the domestic petroleum and gas industries will be handled by the Petroleum Administration for Defense, according to an agreement signed by PAD and National Production Authority Nov. 16. NPA will still determine the amount of steel the industries will get, but its distribution to individual companies will be handled by PAD.

Synthetic rubber production will reach 760,000 tons annually by early spring, Reconstruction Finance Corp. predicts. Output of general purpose synthetic has been stepped up to rate of 430,000 tons annually from 220,000 tons last January, and is expected to hit 600,000 tons by the end of this year.

• • •

FOREIGN

The Portuguese "Sacor" (Sociedada Anonima Concessionaria de Refinacao de Petroleos em Portugal) is revamping and modernizing its Lisbon, Portugal, plant. When completed, plant will have a capacity of approximately 10,000 b/d. Processes now in operation include topping, vacuum distillation and lube manufacture. A cracking plant is planned for future installation. Born Engineering Co., Tulsa, is handling engineering design and will supervise construction.

South African Coal, Oil & Gas Corp. has been formed in Pretoria, Union of South Africa, as a "public company" to build and operate facilities for the synthesis of liquid petroleum products from coal. It will operate under license issued in 1948 to Anglo-Transvaal Consolidated Investment Co. for manufacturing oil from coal. According to New York sources, any plans for an actual synthesis plant are still in the formative stage.

Petroleos Mexicanos has programs underway to modernize and expand the facilities of its refineries at Tampico, Tamaulipas and Atzcapotzalco. These refineries will incorporate 12,000 b/d Perco Cycloversion units.

• • •

MARKETS, PRICES

Prices were firm to higher in most refinery districts during November. Sales to domestic and export buyers picked up, and the military asked for sizable quantities of refined products for shipment over the first half of 1951.

A cold wave which hit the Midwest late in the month came to the rescue of large distillate inventories and reversed a trend toward easier prices. The continued upward spiral in rates for Gulf-North of Hatteras tanker transportation made for firm prices in the East and caused refiners to withhold offerings of kerosine, No. 2 and residual fuel oils from other than regular customers.

At the Gulf, October's weakness in gasoline prices disappeared, and sales in cargo lots of regular grade, 86 octane Research, were closed at 11c, the low quoted price.

Opinion on inventories and sales of all types of material was generally revised during the month. Refiners at the Gulf, who previously had deplored the continuing advance in tanker transportation rates as a blight to spot sales, swung around to the stand that sufficient demand was developing to move oil regardless of the cost of chartering vessels. Other sources who previously had said the whole lubricating oil market was "overbought" admitted that these products were as difficult as ever to find in the open market.

• • •

TRANSITION

Ashland Oil & Refining Co. has purchased Northwestern Refining Co.'s 3-4000 b/d skimming plant at St. Elmo, Ill. Shut down for at least two years, plant has "make shift" thermal cracking facilities. Ashland may operate it temporarily to ease Midwest fuel oil shortage, but longer operation is problematical.

Socony-Vacuum Oil Co. has sold its Long Island City refinery and bulk plant, idle about a year, to real estate operators. New owners plan to resell buildings and equipment, and convert tract into industrial development. Equipment included lube, wax and candle-making facilities, dockage, rail siding, garage and tankage.

• • •

MISCELLANY

First national annual Diesel fuel survey on types and quality of such fuel now marketed has been issued by Bureau of Mines, in cooperation with API. A free copy of RI 4746, "National Annual Diesel Fuel Survey, 1950," can be obtained from Bureau's Publication Distribution Section, Pittsburgh.

Present nomenclature for crankcase oils should not be changed, according to recommendation of a special subcommittee of API Lubrication Committee. Subcommittee suggested it was "impossible to prepare a satisfactory rewrite of the API nomenclature . . . until such time as the situation regarding the various heavy duty oils has been better clarified by experience." Present nomenclature includes "regular," "premium," and "heavy duty" oils.

Sun Oil Blends Lube Oils

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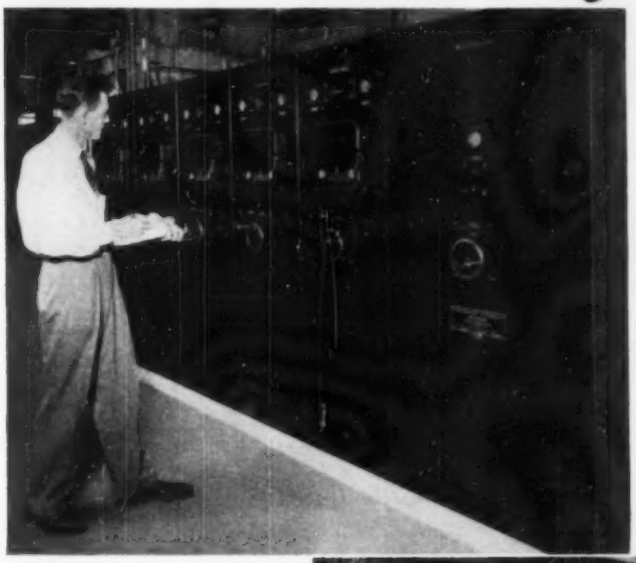
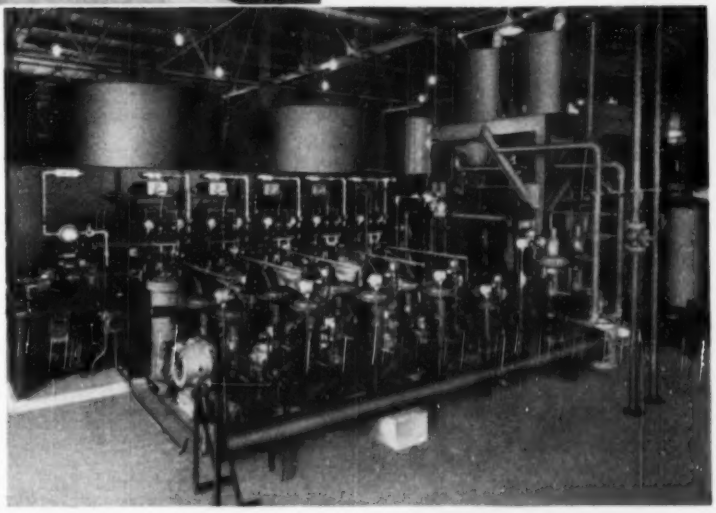


Sun Oil Company's new lube oil packaging plant at Marcus Hook Refinery, one of the world's largest, employs two %Proportioneers% Continuous Automatic Blenders to produce its finished products in a wide variety of formulations accurately to specifications. One of these blenders, five-component of 350 g.p.m. capacity, regularly produces high v.i. oils and the other, seven-component of 350 g.p.m., produces low v.i. oils. These blenders can be quickly set to produce lube oils having a wide range of viscosity indexes, to any formula involving from one to twelve components, and in any quantity to its capacity of 350 gallons per minute. By providing for recirculation and by totalizing each component, %Proportioneers% Continuous Automatic Blender provides a positive check of composition without wasting stocks. Flows are stabilized before being combined in the blend manifold and even the largest capacity system can blend small batches with extreme precision.

Control Panel No. 1 of %Proportioneers% Blenders at Sun Oil Co.

Blender mechanism regulated by Control Panel No. 1.



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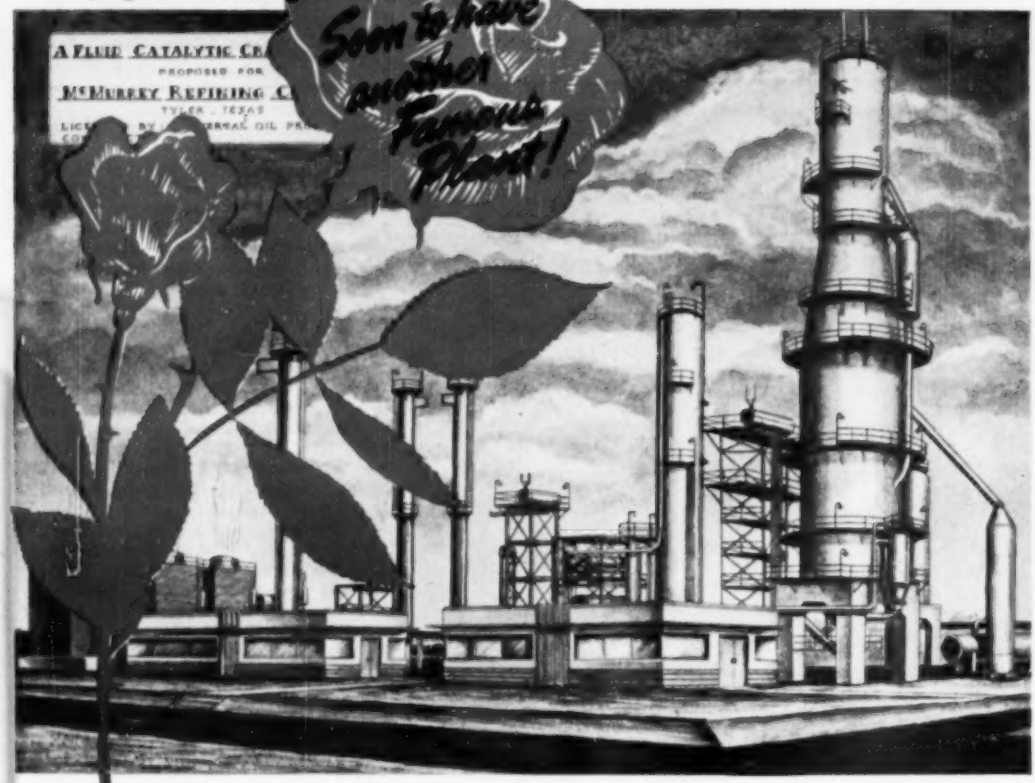

REFINERY ENGINEERING Company has been chosen by McMurrey Refining Company of Tyler, Texas, to build their new Cat Cracker and to revamp their existing facilities.

The new unit will be a 6,000 barrel per day UOP Fluid Catalytic Cracker with all detailed engineering and construction by REFINERY ENGINEERING Company.

In keeping with the TRECO trend in refinery design, plate glass windows will be used on the front of the Compressor Room, Blower Room and Control Room. This will provide an inviting view to the public and will show the position achieved by modern refineries toward better plant housekeeping. Thus, McMurrey Refining Company's new installation will be an attractive part of a city that is known far and wide for the beauty of it's roses.

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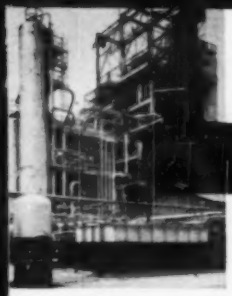

TOMORROW... IN PETROLEUM TECHNOLOGY

Possible Effects of Today's Developments On Future Operations

Benzene Made from Normal Hexane on Laboratory Scale

EXPERIMENTAL work carried on at the University of Kansas on the synthesis of aromatics from aliphatic hydrocarbons has included the recovery of benzene from normal hexane.[1] Provided the conversion is feasible many considerations favor starting with n-hexane, rather than methylcyclopentane, the raw material in the present commercial method for producing this aromatic from petroleum hydrocarbons.

"Thermodynamically the reaction

n-hexane → benzene + hydrogen

is favorable above 350° C. Also, large quantities of normal hexane are available from natural gasoline sources and highly paraffinic crudes at relatively low prices (6 to 8c gal.). Further, gasoline stocks having a good octane number are not depleted to furnish a source of aromatics. Finally, if reasonable yields can be obtained, the separation of the benzene from hexane may be achieved simply by fractional distillation."

The experiments at the University of Kansas have demonstrated, it is reported, that the process can be conducted at atmospheric pressure and approximately at the same liquid space velocity as the hydroformer operation. It is thought the catalyst used can be reactivated with air and nitrogen mixtures. While the fluid catalyst principle could probably be used, a unit of the fixed bed hydroformer type would approximate the arrangement used in the experimental work. The principle of cyclization used could be employed to produce other aromatic materials from aliphatic compounds.

A possible explanation of the low or negligible conversion of the aliphatics to aromatics in the hydroformer reaction may be the high pressures employed and the high partial pressure of hydrogen.

"These two factors may have combined to diminish the rate of the cyclization reaction and to give a poorer equilibrium condition."

Data from a typical run on the benzene from n-hexane experiments are reported in Table 1. Conversion per pass is high and experience has shown that the hexane-olefin reaction can be recycled to produce more benzene. While a pure n-hexane cut was used in the laboratory work, a normal hexane cut from a gasoline column would be used in the commercial operation.

Rough economic calculations given in the report show that 21.6 gals. of benzene would be produced and 38.4 gals. of a mixture of hexane and olefins would be recycled. Neglecting any credit for other materials produced, net cost of the feed stock would be \$3.70 @ 6c/gal. and the value of the benzene produced would range from \$4.32 (@ 20c/gal.) to \$8.64 (@ 40c/gal.)

A later method, based on a different reaction for cyclization of hexane, is reported as having been originated and developed at the University of Kansas, and is now the subject of a patent application. It is known as the "Kansas Process."

Benzene is present in crude petroleum in such small quantities that direct extraction is impractical because of cost. In the present commercial method in use methylcyclopentane is isomerized to cyclohexane and this, together with that naturally occurring in the crude, is dehydrogenated to benzene, joining that naturally in the crude, and the combination is then extracted. However, the yield of benzene is only on the order of a third or a fourth of that of toluol, for which this method was originally developed, thus making it a high cost method for the synthesis of benzene. Lower cost methods and methods using materials less desirable as high octane gasoline components will, undoubtedly be the subject of intensive study in the petroleum refining and chemical manufacturing industry.

TABLE 1—Catalytic Cyclization of N-Hexane to Produce Benzene

(Single Pass Data)

Feed: n-hexane; pure grade 99 mole %; Phillips Petroleum Co.
Catalyst: Chromia-alumina
Catalyst Volume: 1350 cu. cm.
Reactor Diameter: 5.25 cm.
Reactor Temperature: 510° C.
Pressure: Atmospheric
Length of Run: 137 min.
Space Velocity: 0.71 cu. cm. liquid feed/(hr.) (cu. cm. catalyst)
Contact Time: 10.3 seconds
Mass Velocity: 8.1 x 10^{-3} gr./(sq. cm.) (sec.)
Feed Rate: 15.9 cu. cm./min.
Feed, Total Volume: 2179 cu. cm.
Products:

Carbon deposited on catalyst	29 gm.
Gas produced	30 cu. ft.
Adsorbed on charcoal	377 gms.
Liquid Product (total recovered)	1316 c.c.
Gravity 0.74; n_D^{25}—1.426	
Benezene in liquid product	36 vol. %
Hexane in liquid product	47 vol. %
Olefins in liquid product	17 vol. %
Liquid Produced Based on feed	60 vol. %
Benzene Produced Based on feed	21.6 vol. %

Synthetic Fuels Work Needs Careful Study

A FEW years—and even months—ago, much was heard of the desperate need for the immediate construction of an industry to produce synthetic liquid fuels and other products from coal. Stress was placed upon the growing demands for gasoline and fuel oils and the pinch which would be felt in an emergency if huge synthetic fuel plants were not rushed into immediate being, regardless of economics. Fortunately *or* unfortunately—only time will supply this answer—other counsel prevailed. Moreover, now that construction materials will undoubtedly be needed in increasing quantities for numerous critical purposes, it seems highly unlikely that vast quantities of (fabricated) materials can be diverted to the erection of numerous plants to produce synthetic fuels.

Not that study of methods and materials will or should be stopped—and with this all are agreed. Much good scientific and technical data have come from the investigations of the petroleum industry and—beyond all debate—from the studies of the Bureau of Mines. Economic interpretations of their significance, indeed, have differed considerably, but that is all the more reason for further study in the laboratory and pilot plant.

The recent three-year, \$27,600,000 extension of the Bureau of Mines' program—which will carry it until April, 1955—should enable that agency to develop exceedingly valuable information on processes, products, and—of paramount importance—the fundamentals of the field. Much empirical knowledge is already available; what is vitally needed is background work which can help to explain "why" and, eventually, to give clues as to "how" things can be done when the time is more propitious.

One study which illustrates this point was described in a recent paper presented before the American Chemical Society. Reporting on the "Properties of Selected Colorado Oil Shales," I. C. Frost, *et al.*, of the Bureau of Mines told that society that the yield of assay products from six shales studied was related to the total organic content or richness of the shale. The degree of conversion of this organic material was not greatly affected by the richness of

the shale. It was found that "specific gravities, bulk densities, and gross heating values of the shales were related to their oil yields and may be used as a rapid method of estimating the oil yields of similar shales." However, the composition of the assay gases from these shales was similar.

Frost and his coworkers found that "natural weathering did not cause any significant reductions in the oil yields of the shales for periods up to six months, but longer weathering periods resulted in decreased oil yields and increased water yields. The weathering was more pronounced for the rich oil shales."

It now seems fairly clear that chief attention, in the study of synthetic liquid fuels, will continue to be focused on the Synthine (Fischer-Tropsch) process, shale oil, and coal hydrogenation. For example, while it received a one-day hearing,(2) "a bill sponsored by a group of Minnesota congressmen to authorize Government funds for experiments in the development and use of peat as a commercial fuel" will apparently not receive further action, especially since a Department of Commerce representative stated that "it is not likely that the present and future supply and demand situation would justify expenditures for research on the utilization of peat for the purpose of transporting and marketing the commodity as a fuel in competition with higher-grade coals, oil, and gas," or on its use in the synthesis of liquid fuels.

Some day, synthetic liquid fuels will almost certainly be an important or dominant market factor. That day, however, has probably been postponed.

Computers Free Engineers For More Important Work

ONE of the most significant technological developments of the twentieth century has been the "machines that think," the giant electronic calculating units capable of solving the complex mathematical problems associated with, among other things, engineering design.

Man's progress in making machines perform physical labor pales before the accomplishments of some of these devices. Their importance and potential value to the petroleum processing industry is only beginning to be realized. Some of the possibilities were disclosed recently when 75 representatives of the petroleum, chemical, automobile, industrial research laboratories, and other industries met at International Business Machines Corp. laboratories at Endicott, N. Y. for a Seminar on Industrial Computation.

One particular problem was connected with the design of fractional distillation towers for a chemical plant. Its solution would have required more than six hours using a slide rule or a desk-type adding machine. An early model punch-card, electromechanical relay calculator obtained the answer in 46 minutes of computing time. This problem was described by Drs. Ascher Opler and Robert G. Heitz of Dow Chemical Co., Pittsburg, Calif.

Another even more striking example of time saving, described by Drs. Arthur Rose, William S. Dye, and Theodore Williams of Pennsylvania State College, employed an electronic device with 1500 tubes capable of multiplying about 45 pairs of ten-digit numbers in a second. One project took two men using a desk-type adding machine (one computing, the other writing down answers) 375 days of working time. The computor did equivalent work in 60 hours.

Seminar speakers emphasized, as have many other scientists, that machines will not replace chemical engineers. The results still have to be analyzed carefully on the basis of experience and human judgment, but high speed calculating will free the engineer for more important work.

Trend in Refinery Use Of Natural Gas Liquids

THE detailed figures for 1949 on natural gas liquids processed at natural gas liquids processed at natural gasoline and cycling plants, as reported by the U. S. Bureau of Mines,(3) are of more than historical significance in that they show a definite trend toward the greater utilization of LP-gases in refineries, perhaps at the expense of natural gasoline products as such. On this point the report states:

"Shipments of natural gas liquids to refineries totaled 3,764,960,000 gals., in 1949, representing 56% of the total demand. A definite pattern has been established during recent years, clearly indicating the declining relative importance of sales of light liquids to refineries. A slight gain (0.5%) was registered by natural gasoline shipments to refineries during 1949, when 2,770,418,000 gals. were received. Shipments of LP-gases to refineries totaled 513,162,000 gals., a 19% gain from 1948. Condensate shipments to refineries dropped 1.9%.

"Normal butane shipments to refineries in 1949 increased 97%, while isopentane dropped 10% and isobutane 18% compared with the preceding years."

Table 2 prepared from the Bureau's report, gives the shipments of the various natural gas liquid products to refineries for the two years, while Table 3 shows the utilization of natural gas liquids in refineries, by refinery districts. The most significant change given in Table 2 is an increase of almost 90% in the use of such products in the East Coast refining district. Gains in other districts were around 14% in California and approximately 10% for the Indiana-Illinois-Kentucky and the Gulf Coast districts.

The total demand for natural gas liquids processed at natural gasoline and cycling plants in 1949 increased 7% from the 1948 figure. As compared with the very slight gain in shipments of natural gasoline, total shipments of LP-gas products were 9% higher in 1949. Shipments of condensate declined 2%, while those for finished gasoline and naphtha gained 25%.

References

(1) Report from University of Kansas Research Foundation, "Benzene from Normal Hexane", by Morris Teplitz, Arthur Inman, J. O. Maloney and J. B. Sutherland.
(2) *National Petroleum News*, Aug. 30, 1950, p. 11.
(3) "Natural Gasoline and Liquefied Petroleum Gases," by G. W. Cale, E. M. Seeley, A. F. Coumbe and I. F. Avery, preprint from Bureau of Mines Minerals Yearbook for 1949.

TABLE 2—Shipments to Refineries of Natural Gasoline and Allied Products, 1948-1949

(1000 gallons)

Product	1948	1949
Natural gasoline and natural gasoline mixtures	2,757,880	2,770,418
Butane, normal	124,578	238,060
Isobutane	187,367	153,181
Isopentane	55,210	49,755
Other LP-gases	68,571	72,166
Finished gasoline and naphtha	145,395	142,451
Condensate	345,629	338,929
TOTAL	3,680,621	3,764,960

TABLE 3—Utilization of Natural Gasoline and Allied Products, by Refining Districts, 1948-1949

(1000 gallons)

District	1948	1949
East Coast	37,044	70,980
Appalachian	25,908	22,974
Ind.-Ill.-Ky. etc.	353,766	394,842
Okla.-Kans.-Mo.	316,008	338,982
Gulf Coast (Texas and La.)	902,622	1,003,842
Inland Texas, La. and Ark.	614,082	635,116
Rocky Mountain	42,672	56,709
California	909,762	1,045,758
TOTAL	3,201,954	3,589,194

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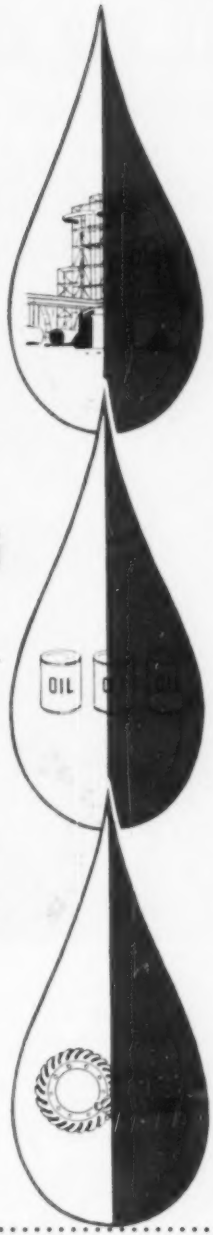

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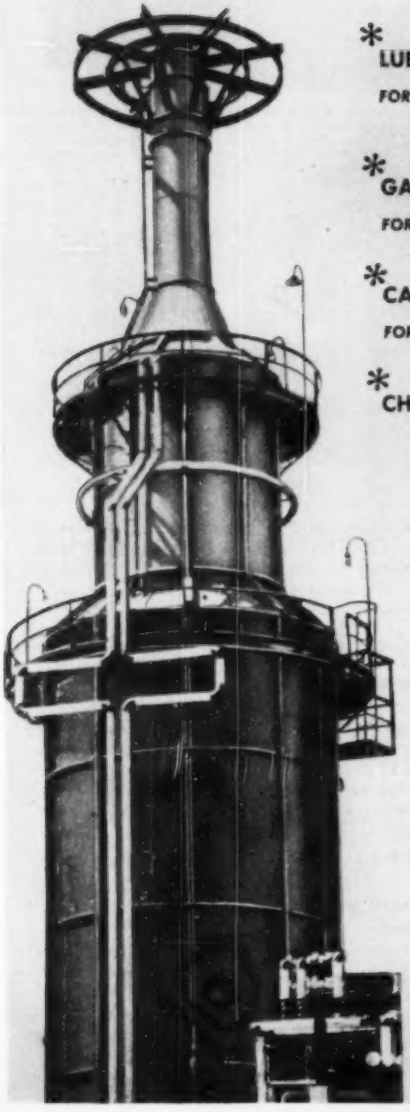

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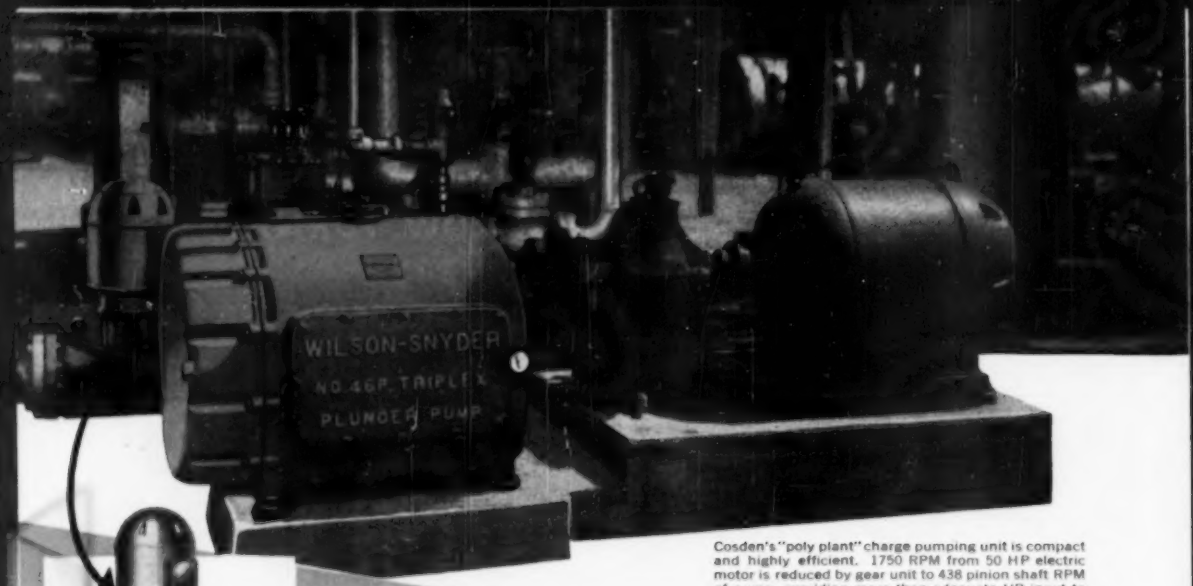

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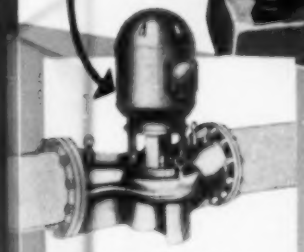

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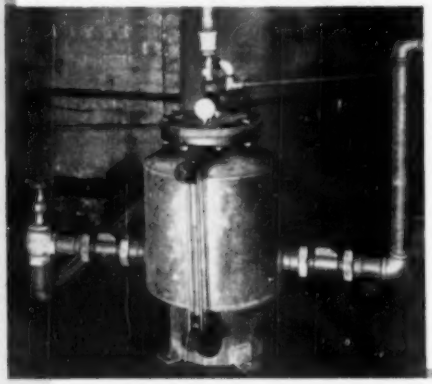

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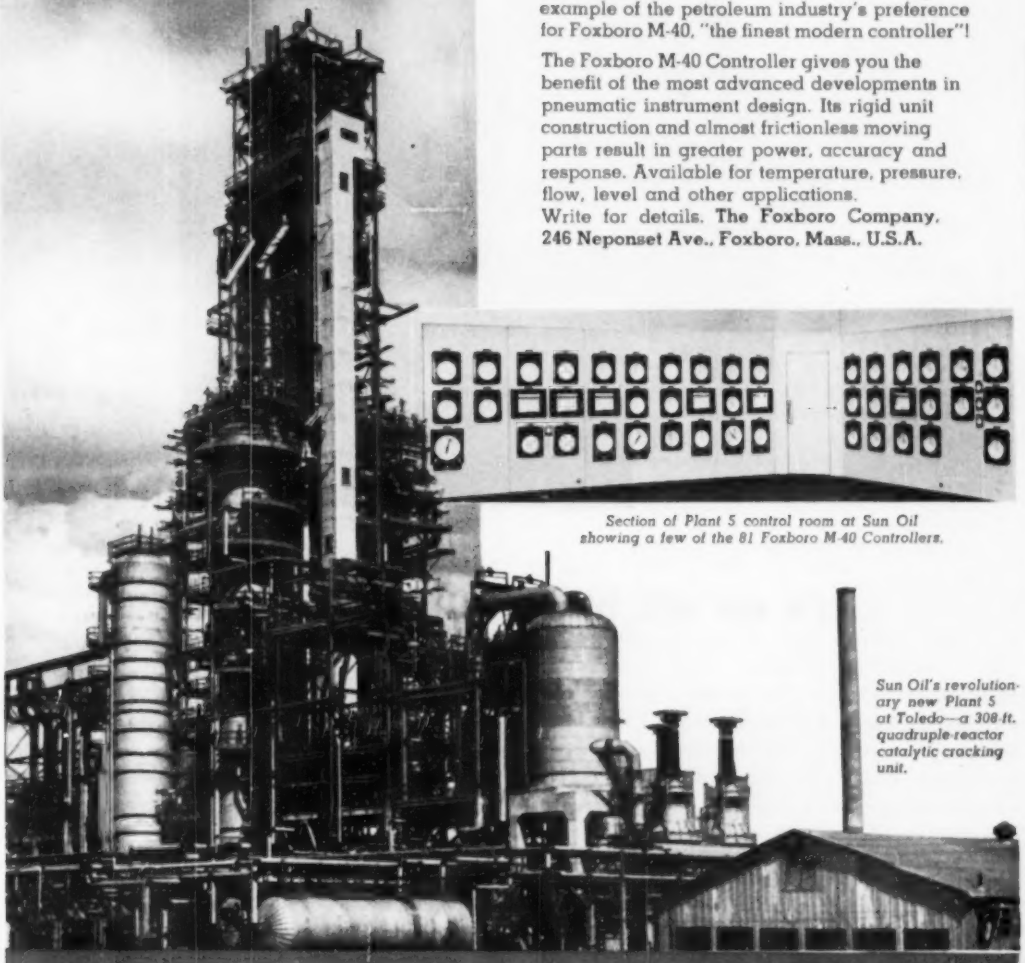

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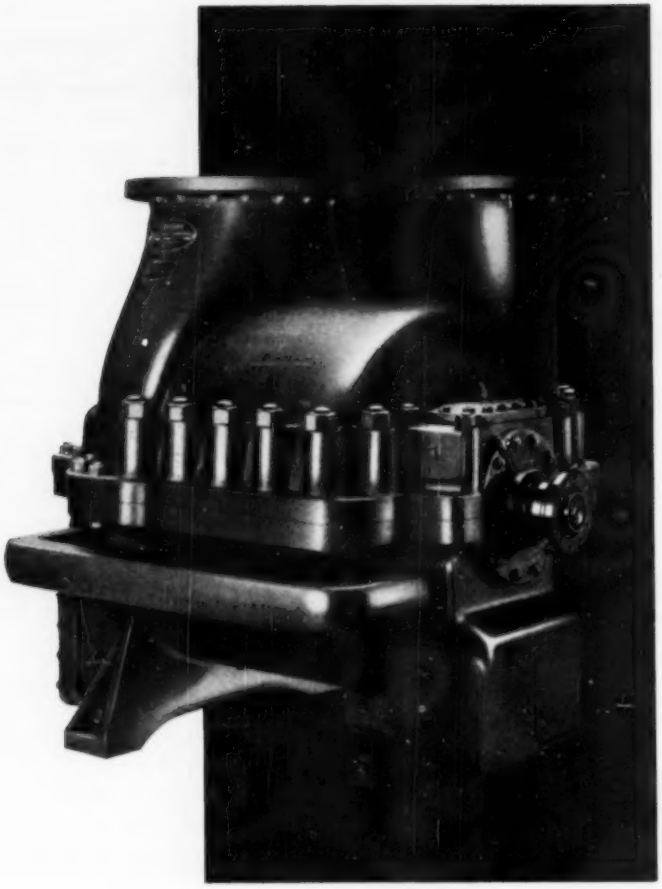

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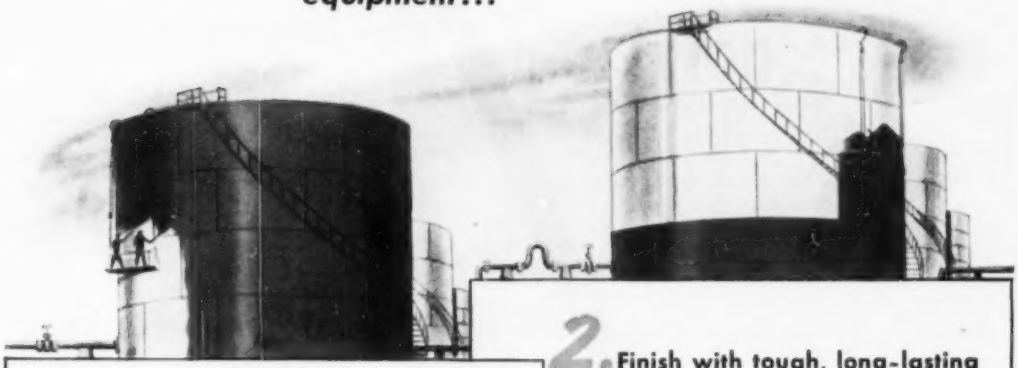

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For valves, pipeline identification, pumps, motors, use S-W KEM LUSTRAL—a synthetic enamel that has been the choice of industry for a generation. Durable, highly resistant to abrasion, corrosion, and to the action of salt, chemicals, and hydrocarbons, it is ideal for petroleum applications.

S-W KROMIK Metal Primer, KEM Synthetic Tank White and KEM LUSTRAL Enamel are only three of a complete line of finishes engineered by Sherwin-Williams for the petroleum industry. Ask for data on finishes for your requirements. Write The Sherwin-Williams Co., Transportation Division, Cleveland 1, Ohio.

SHERWIN-WILLIAMS

MAINTENANCE FINISHES FOR THE PETROLEUM INDUSTRY

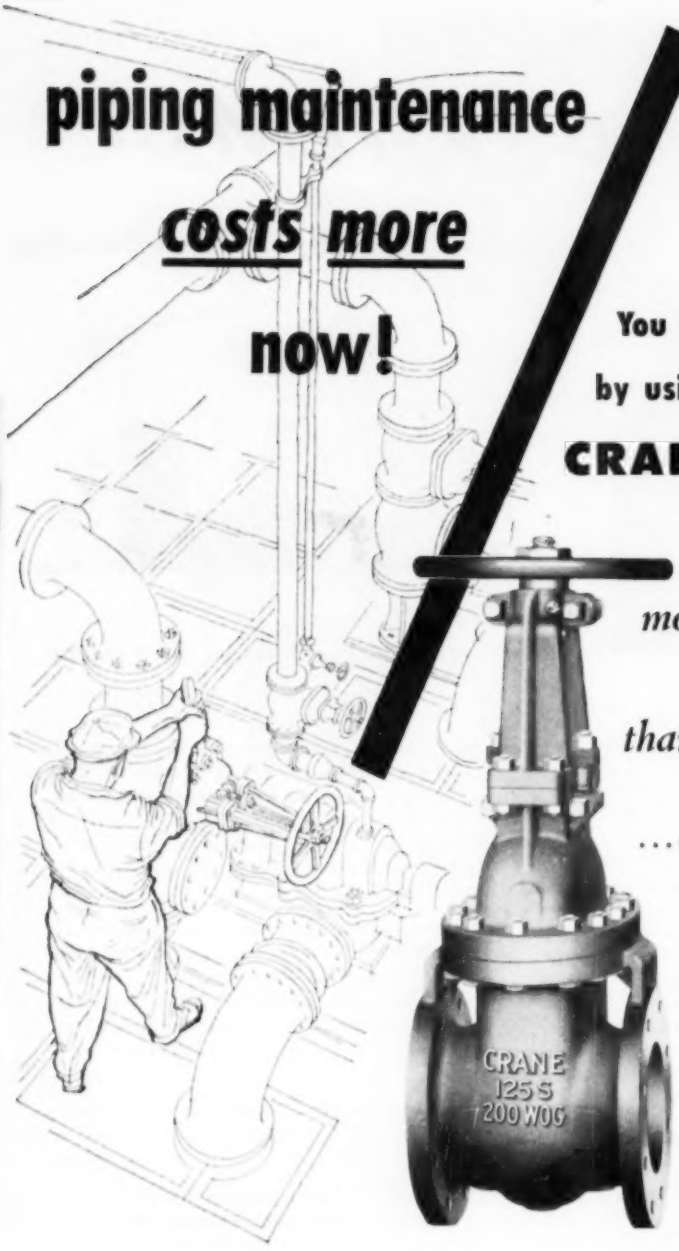
piping maintenance *costs more* now!

You do less of it

by using Dependable Quality

CRANE VALVES

That's why more Crane Valves are used than any other make



. . . no bonnet trouble with this valve

A typical example of low-maintenance Crane Quality—No. 465½ 125-Pound Iron Body Gates. Rarely does the bonnet joint need attention. Flange construction includes reinforcement to prevent distortion and utilizes more bolts, more closely spaced than is usual in valves of this class. Crane precision-guided seating reduces seat and disc wear. Packing has long life because these valves have a deep stuffing box filled with high grade asbestos ring packing. A ball-type gland equalizes the packing load.

Better performance features like these make Crane the better buy in valves of every type. Ask your Crane Representative for a demonstration.

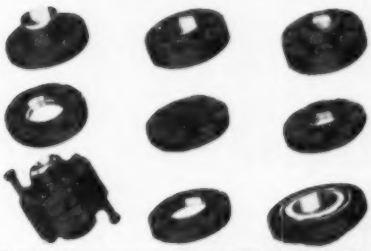
CRANE

CRANE CO., *General Offices:*
836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

SEAMLESS WELDING FITTINGS

½-inch through 36 inches
Standard through Double Extra Strong



FORGED STEEL FLANGES

½-inch through 30 inches
150 lbs. through 2500 lbs. pressure

FORGED STEEL FITTINGS

Screwed and Socket Welding
⅛-inch through 4 inches
2000 lbs. through 6000 lbs. pressure

LONG WELDING NECKS

1-inch through 24 inches

LARGE O. D. FLANGES

26 inches through 96 inches

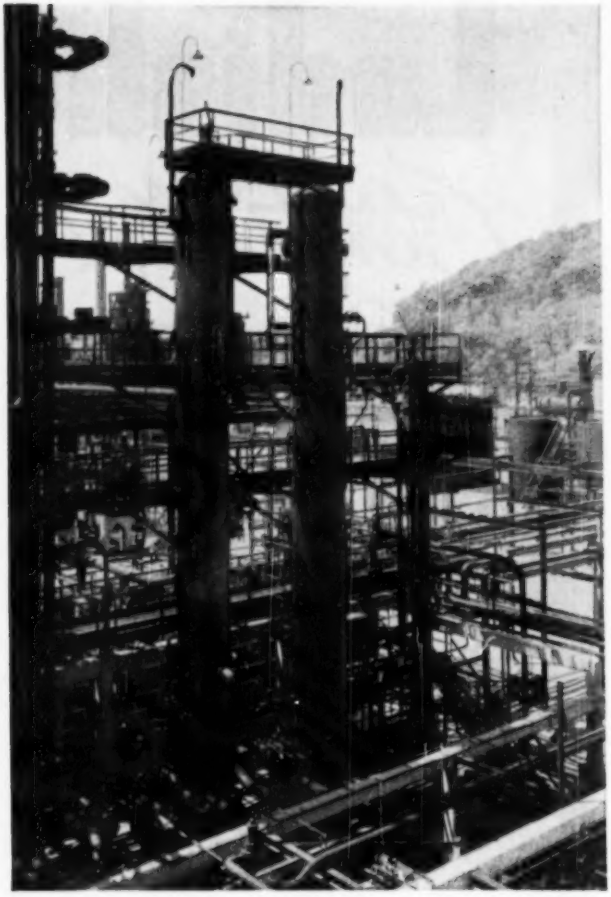
Ladish *Controlled Quality* FITTINGS

A COMPLETE LINE PRODUCED UNDER ONE ROOF

Ladish is prepared to serve you . . . whatever your fitting needs may be. This outstanding line offers you an unlimited selection of types, sizes, weights, pressure ratings and materials . . . the most dependable of quality controlled Seamless Welding Fittings, Forged Steel Flanges, Forged Steel Fittings, Large O.D. Flanges and Long Welding Necks. Standardizing on the Ladish Line simplifies procurement, assures uniform quality and satisfaction.

For prompt, efficient service on Ladish Fittings —and on all types of refinery equipment and supplies—look to Franklin Supply Company. Here is an aggressive organization that can become an integral part of your business by supplying *what* you want, *when* you want it.

FRANKLIN SUPPLY COMPANY 624 S. MICHIGAN AVE. CHICAGO 5, ILLINOIS



Uses **Girbotol** plant to purify both **Liquid** and **Gaseous** hydrocarbons

THIS NEW REFINERY gets double duty from its Girdler Girbotol Plant. Using a common reactivator, the Girbotol Plant removes hydrogen sulphide from both liquid and gaseous hydrocarbons.

The gas absorber handles a fuel gas stream flowing at the rate of 700,000 SCF per day. In the liquid-phase section, a propane-butane stream of 4100 barrels per day is purified.

The Girbotol process has proved to be the most economical method known for separating hydrogen sulphide from liquid hydrocarbons such as butane, propane, poly-feed stocks, straight-run naphthas and gasolines; and from natural, refinery and other gases.

For engineering assistance on all problems involving gas manufacture, purification, separation or utilization, write or call on The Girdler Corporation.

Works speak louder than words

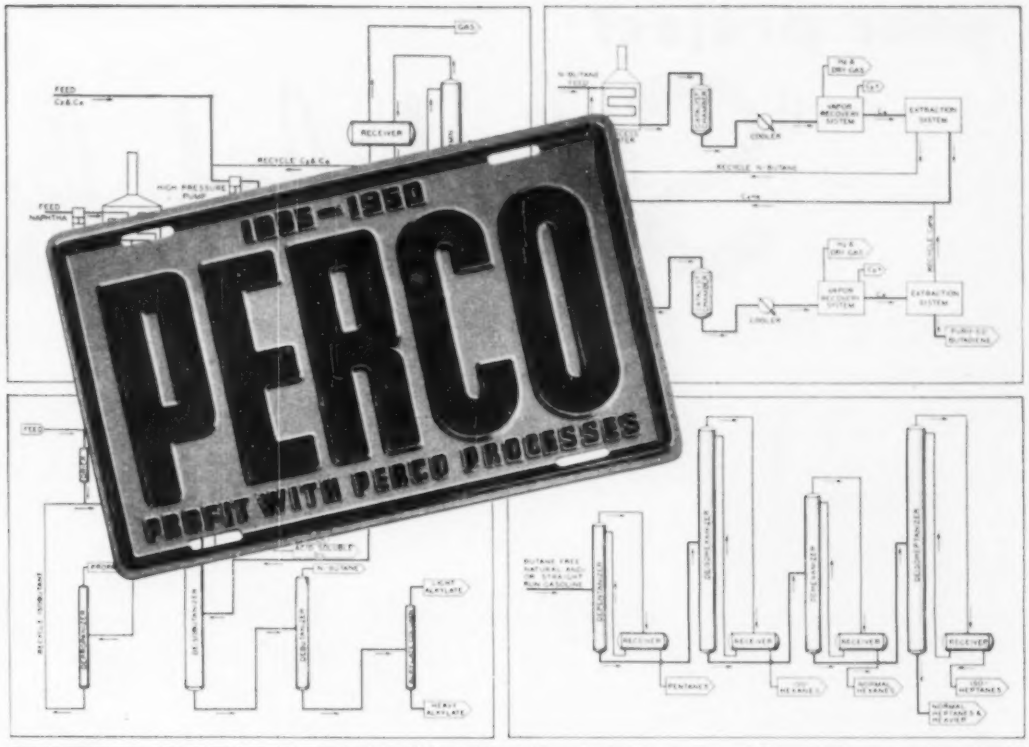
GAS PROCESSES DIVISION

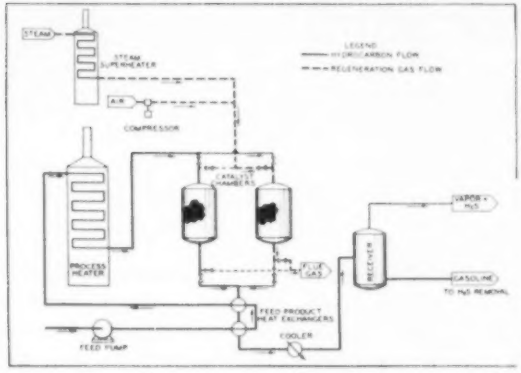
THE *GIRDLER* CORPORATION

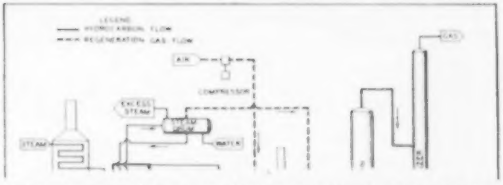
LOUISVILLE 1, KENTUCKY

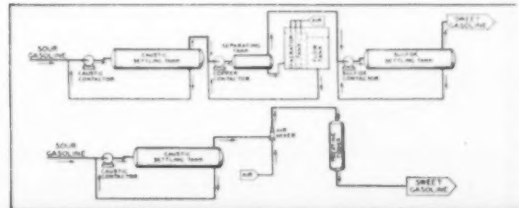
District Offices 150 Broadway, New York City 7
2612 Russ Bldg., San Francisco 4
311 Tuloma Building, Tulsa 3

Designers, Engineers and Constructors









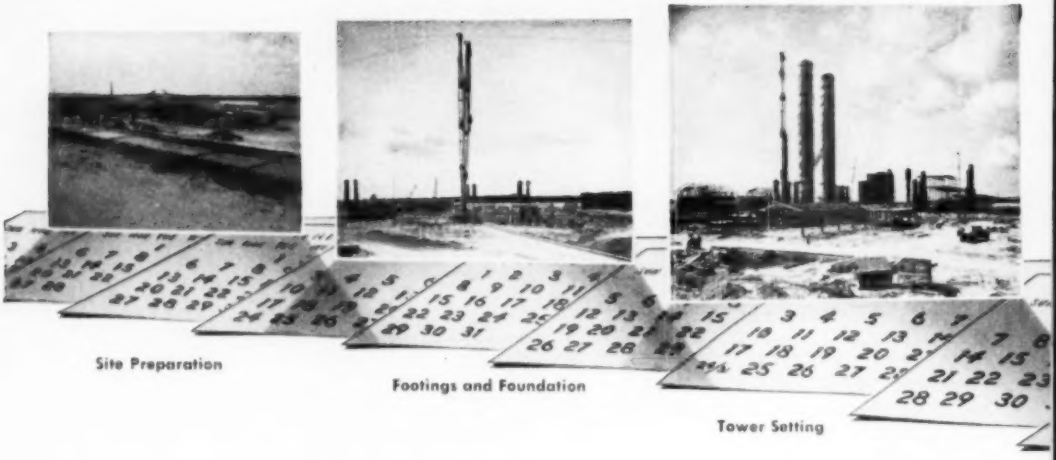
OVER 120 INSTALLATIONS —LICENSED BY PERCO*

Perco Processes are exceedingly flexible and widely applicable to many of the problems facing refiners today. Versatility of Perco equipment enables you to upgrade your finished product in line with market trends without resorting to heavy capital investment, elaborate instrumentation or high cost catalysts. For more background on Perco's achievements, call on us. We'll be glad to help you assess the potential increase in profits per barrel of your finished products through the utilization of proved Perco Processes.

*A SERVICE MARK

PERCO DIVISION
PHILLIPS PETROLEUM COMPANY
BARTLESVILLE, OKLAHOMA

your project "Scheduled by



Scheduled by Lummus means engineering and construction is a complete integration of planning, forecasting and cost control, applied with individual responsibility from start to finish. Lummus' complete scheduling of your refinery project smooths the work flow. There is no wasted effort. You can count on delivery of an economical, well functioning plant on or before the required completion date.

Scheduled by Lummus means plant engineering starts earlier than conventional work planning. It begins with original process design and job engineering. Because time is money, the project is engineered from the start with emphasis on time-economies in the entire erection operation. Erection methods are analyzed in advance from the standpoint of practical application at the site.

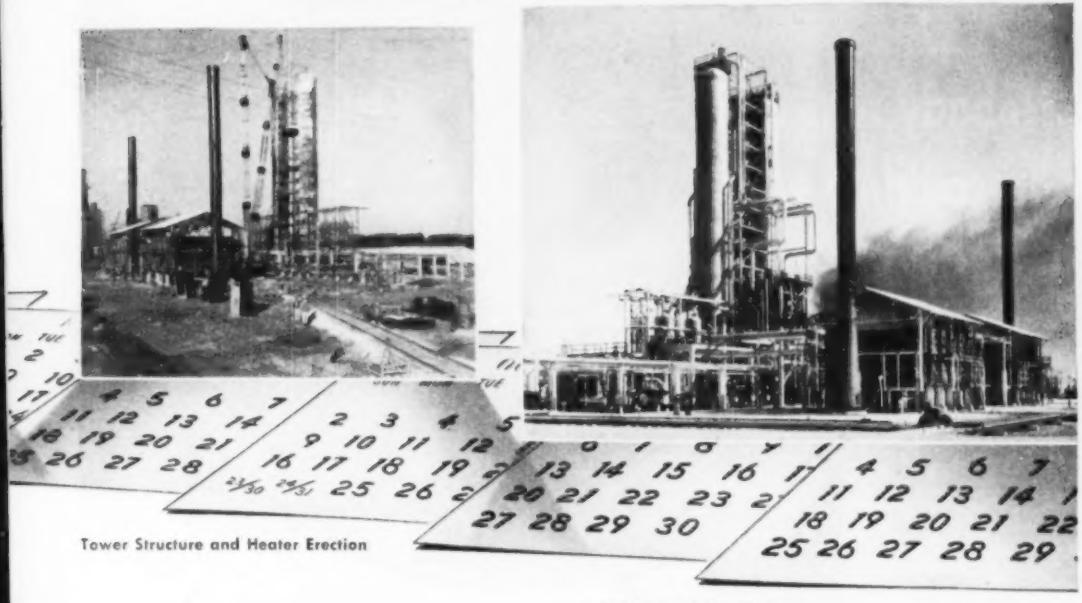
THE LUMMUS COMPANY
385 Madison Avenue, New York 17, N. Y.

LUMMUS

CHICAGO – 600 South Michigan Avenue, Chicago 5, Ill.
HOUSTON – Mellie Esperson Bldg., Houston 2, Texas
The Lummus Company, Ltd., 525 Oxford St., London, W-1, England
Société Française des Techniques Lummus
29 Rue Cambon, Paris 1er, France
Compania Anónima Venezolana Lummus – Edificio "Las Gradillas"
Esquina Las Gradillas, Caracas, Venezuela

Lummus"

means READY ON TIME



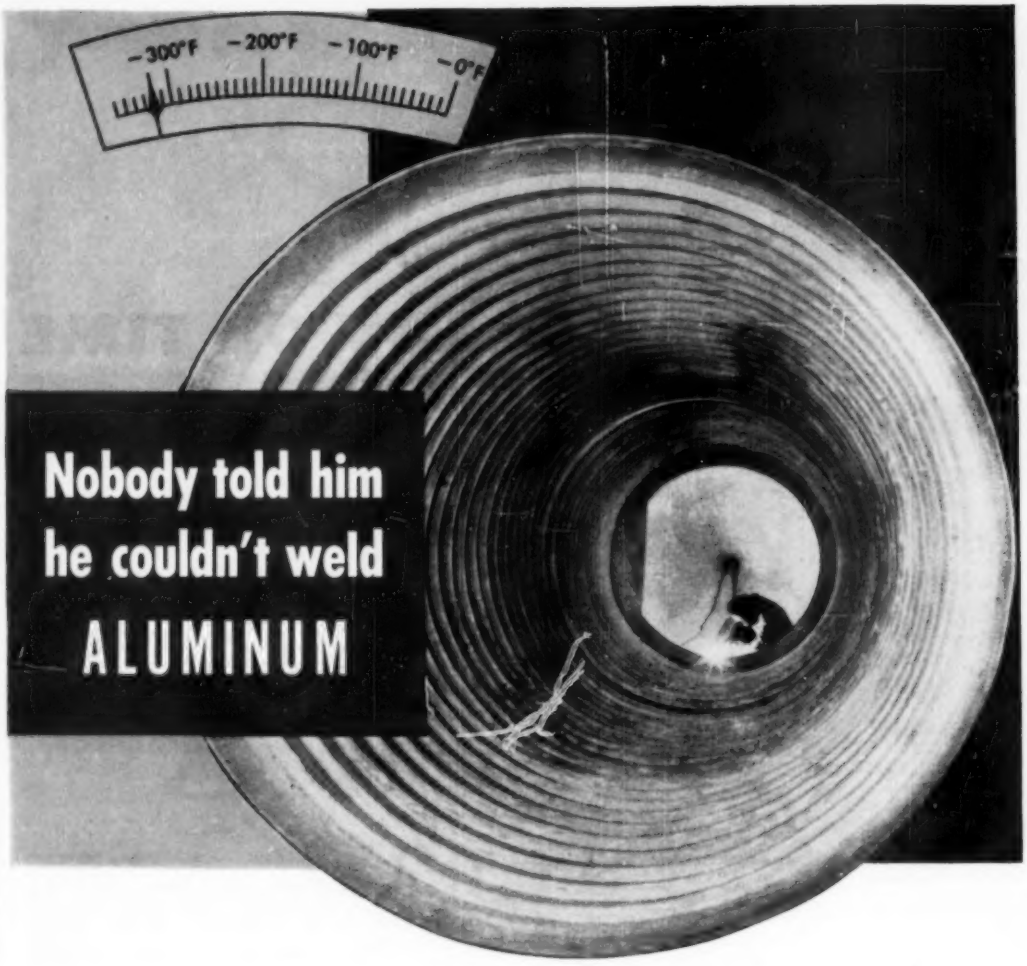
Tower Structure and Heater Erection

Start-up and Operation

Scheduled by Lummus means all materials are planned to arrive as needed. Just the construction tools and skills required for the immediate use of these materials are provided at each successive stage of the job. Costs are kept under day-to-day scrutiny and control. Problems of delivering, erecting and coordinating individual units into an operating whole are anticipated, with hundreds of previous records as a guide.

Lummus' wide range of experience is the key to this thorough and advanced method of procedure. One recent job went from letting of contracts to successful operation in eight months. Another complete foreign refinery was completed in fifteen months. Your next project, "scheduled by Lummus" can be the answer to realistic cost control and the economies that come with completion on or ahead of schedule.

PETROLEUM HORIZONS, the new 80-page book on Lummus processes and plants, features a step-by-step description and flow sheets for 31 refinery processes. It brings you complete details on the background, organization and world-wide services of the Lummus Company. Your copy available on request.



Nobody told him he couldn't weld ALUMINUM

So he's welded 37 aluminum rings—7 feet in diameter—into this low-pressure oxygen plant, bubble cap tower of Alcoa Aluminum. And very nicely, too. Welding aluminum is no harder than welding other metals. Just follow recommended, simple procedures and you'll have smooth, tight joints every time. Gas, arc, resistance . . . aluminum takes them all.

But ease of welding is only one of the reasons you'll want aluminum for sub-zero process equipment. It costs 25 to 50% less than other suitable metals. Alcoa Aluminum gets stronger and tougher as temperatures drop. Shows no signs of embrittlement at temperatures down to –320°F and lower. Use of aluminum speeds fabrication, reduces maintenance and increases the efficiency of exchangers and expanders.

For more information, mail the coupon below to: ALUMINUM COMPANY OF AMERICA, 1477M Gulf Building, Pittsburgh 19, Penna.

Gentlemen:

Please send more information on aluminum's properties and applications for sub-zero process equipment.

Name

Title

Company

Address

City State

ALCOA *first in* **ALUMINUM**

POWELL VALVES

the top choice of American Industry

Powell Makes a Complete Line* of Valves especially adapted to meet the flow control requirements of YOUR industry.

This 1500-pound Cast Steel Pressure Seal Gate Valve with an electric motor operator is one of many Powell designs for the modern Power Plant.

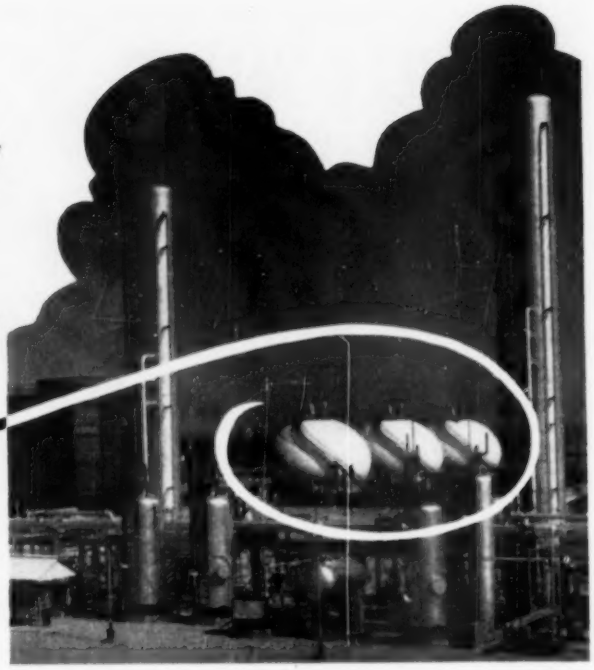
*The Complete Line includes valves in Bronze, Iron, Steel and the widest selection of Corrosion-Resisting metals and alloys ever made available to Industry.

Quality fine throughout "The Line"

POWELL

The WM. POWELL CO., 2525 Spring Grove Ave., P. O. Box 106, Station B, Cincinnati 22, Ohio

The *Where and Why* of storing Natural Gasoline



HERE'S how a modern natural gasoline plant stores its output of this highly volatile liquid.

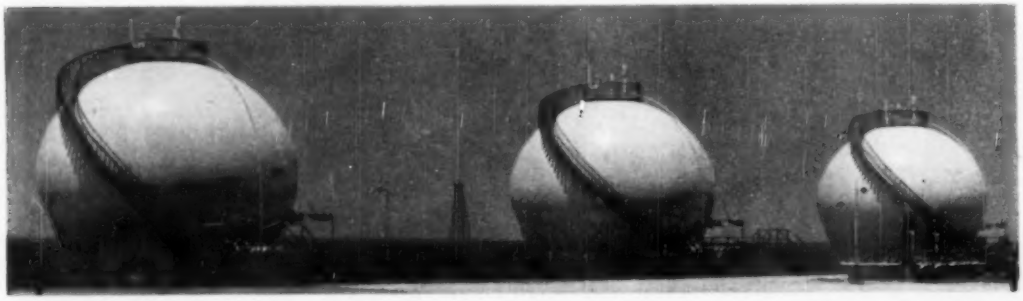
The North Cowden plant near Odessa, Texas, is operated by the Stanolind Oil and Gas Co. for a group of 21 owners. It provides facilities for one of the world's largest gas injection programs. The plant can currently process 50,000 Mcf daily but this can be doubled by adding certain items of equipment. The daily production total of 150,000 gallons of liquid products includes butane, propane and natural gasoline.

Natural gasoline cannot be stored at atmospheric pressure for the light fractions evaporate and are vented. *Where*, (in what type tank) is it held at the North Cowden plant? It is stored *under pressure* in the three 5000-bbl. Hortonspheroids shown in the two views on this page.

Why is a Hortonspheroid so suitable for handling natural gasoline? First, it does not vent the light fractions under normal operating conditions because it can withstand the internal pressure caused by daily temperature changes. These light fractions are important for they give natural gasoline most of its value as an ingredient of blended motor fuel.

The Hortonspheroid is safer, too. By decreasing venting, it prevents the accumulation of explosive or toxic vapors in the storage area.

Hortonspheroids are available in standard capacities from 2,000 to 120,000 bbls. Write our nearest office for Bulletin E for details on dimensions and recommended operating pressures.



CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

Atlanta 3	2103 Healey Building	Detroit 26	1532 Lafayette Building	Philadelphia 3	1630–1700 Walnut St. Building
Birmingham 1	1527 North Fiftieth Street	Houston 2	2130 National Standard Building	Salt Lake City 4	530 West 17th South Street
Boston 10	1029–201 Devonshire Street	Havana	402 Abreu Building	San Francisco 4	1559–200 Bush Street
Chicago 4	2114 McCormick Building	Los Angeles 17	1526 General Petroleum Building	Seattle 1	1330 Henry Building
Cleveland 15	2215 Guildhall Building	New York 6	3310–165 Broadway Building	Tulsa 3	1620 Hunt Building

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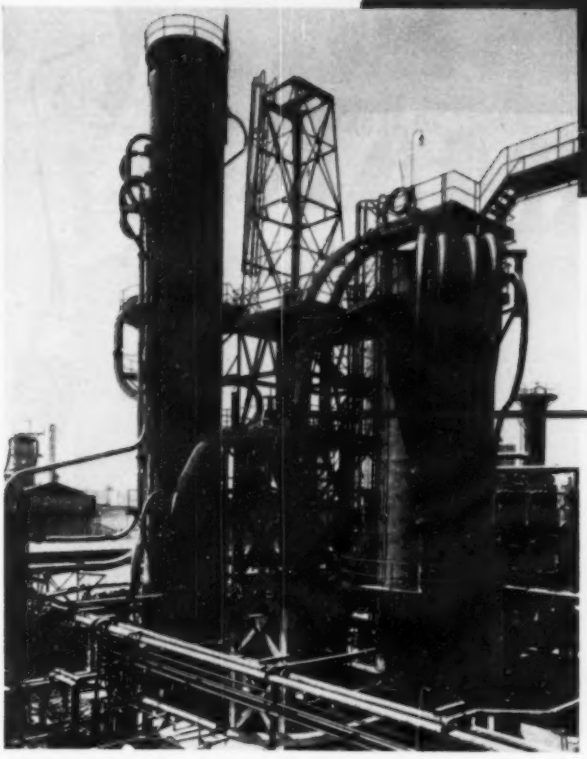
TRET·O·LITE



makes refinery operations *more efficient* *more economical*

By reducing the salt content of charging crudes to a minimum, the Tretolite desalting process helps to eliminate the costly troubles caused by salt. If severe corrosion, plugging and hard coke formation are decreasing your on-stream time and increasing your maintenance costs, why not get in touch with Tretolite? Preliminary tests and a salt survey do not obligate you.

The Tretolite Company also offers these specialized services to refiners:

Water clarification chemicals · Demulsifiers for waste oil emulsions · Corrosion preventive chemicals · Corrosion resistant coatings · Demulsifiers and foam preventers for use in doctor treating and other sweetening solutions

Tretolite Desalting offers these facilities—

Preliminary desalting survey
Laboratory pilot tests
Competent plant design
Construction consultation
Start-up assistance
On-call service

Tretolite Desalting protects against—

Salt plugging
Corrosion from evolved HCl
Hard coke formation
On-stream time losses
High maintenance costs
Impaired equipment efficiency

TRETOLITE COMPANY ST. LOUIS 19, MO.

CHEMICALS FOR THE PETROLEUM INDUSTRY

Dehydrating · Desalting · Water De-Oiling · Corrosion Inhibition
Scale Prevention · Paraffin Removal

T25-1

PROPANE STORAGE FOR PLYMOUTH

furnished by

EACH OF THE 56 VESSELS SHOWN ABOVE ARE 10' 6" IN DIAMETER, 108 FEET LONG AND WEIGH APPROXIMATELY 75 TONS. THEY WERE FABRICATED BY McNAMAR FOR THE HUDSON ENGINEERING CORPORATION FOR INSTALLATION AT THE PLYMOUTH OIL COMPANY PLANT AT RANKIN, TEX. THE SIZE AND QUALITY OF THIS JOB IS TYPICAL OF McNAMAR'S ABILITY IN THE FABRICATION FIELD . . . YEARS OF EXPERIENCE PLUS PRECISION WORKMANSHIP MAKE McNAMAR YOUR BEST BET FOR ANY FABRICATION PROBLEM.

★ McNAMAR TULSA

McNamar Boiler & Tank Co.

REFINERY SALES DIVISION • BOX 868 • TULSA, OKLAHOMA

BOILERS DON'T NEED STEEL CASINGS

B-L's TEXAD* replaces plate, improves furnace efficiency

Eases steel requirements

● TEXAD* eliminates the nuisance of steel plate casings for boilers and other industrial furnaces. As a result, steel quotas can now be devoted solely to pressure parts. TEXAD*—a canvas sheathing impregnated with a specially developed heat-resistant adhesive—is applied directly to the insulation surface, hung just like wallpaper.

Improves air tightness

● The canvas and adhesive finish provides a completely air-tight furnace. Because of its flexible sheathing, TEXAD* prevents shrinkage cracks in the finish coat of insulating cement and acts as a safeguard against air leakage.

Cuts material, labor costs

● The material and labor expense of installing steel casings is greatly reduced by TEXAD*. Some of the resulting savings can be used to secure sounder construction back of tubes for a more balanced furnace design. The net result is a better enclosure—at a much lower cost.

Provides complete weatherproofing

● Because TEXAD* enclosures are completely waterproof, outdoor installations are not affected by rain, snow or sleet. Indoor installations can be washed down at any time. Final jobs can be painted any color, or left white.

*TRADE MARK

A new folder describing TEXAD has just come off the press. Write today for your copy—no obligation, of course.*

BIGELOW LIPTAK Corporation

BIGELOW-LIPTAK

Unit-Suspended Walls & Arches

CURTIS BUILDING • DETROIT 2, MICHIGAN

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BIGELOW-LIPTAK OF CANADA, LTD., TORONTO, ONTARIO

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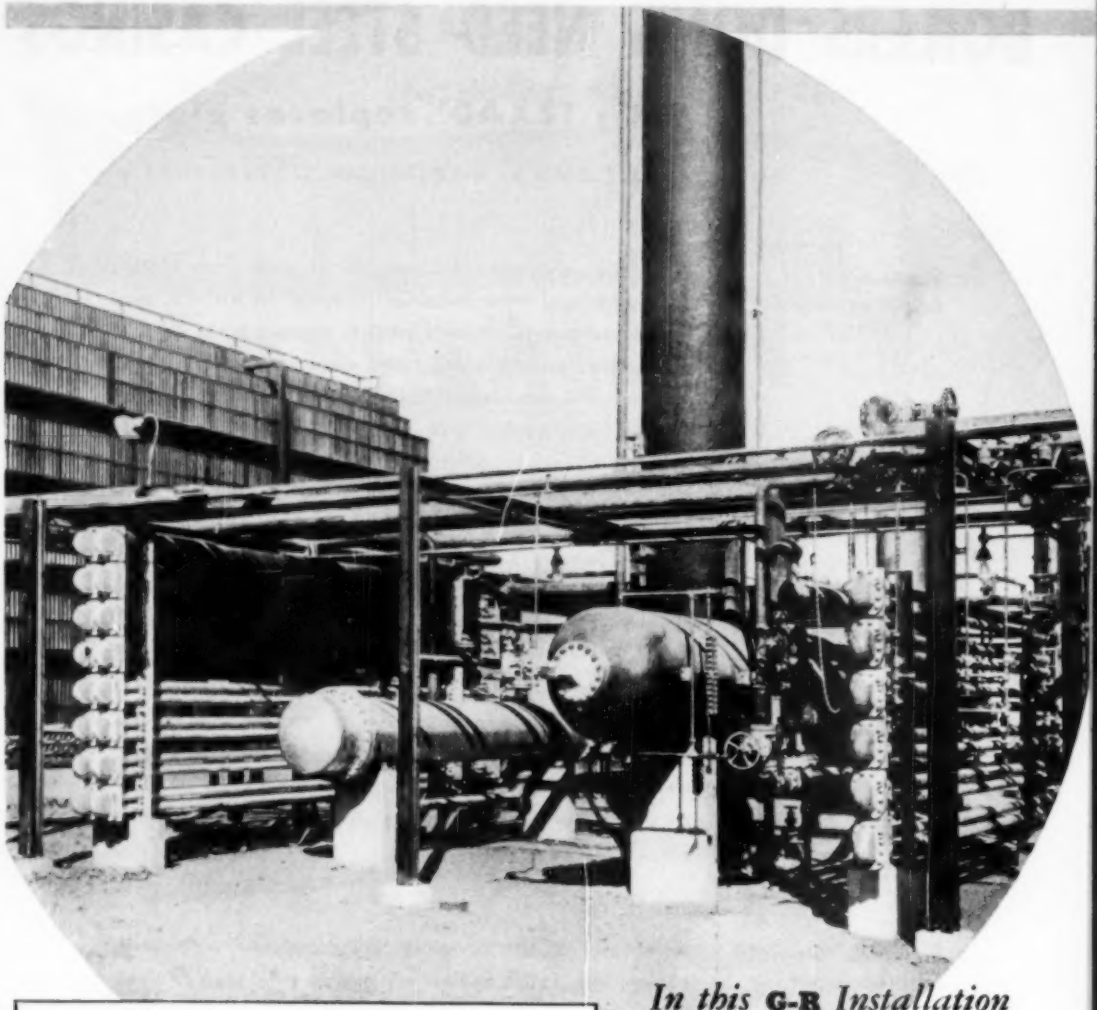
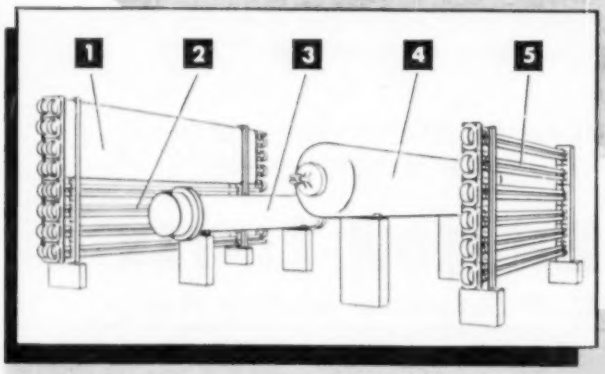




In this G-R *Installation*

1. 8 G-R Twin G-Fin Sections, serving as Stabilizer Exchanger
2. 8 G-R Twin G-Fin Sections, serving as Stabilizer Cooler
3. G-R Type FLT Tubular Stabilizer Condenser
4. G-R Type FSE Stabilizer Reboiler
5. 6 G-R Twin G-Fin Sections, serving as Naphtha Side-Cut Cooler

GRISCOM-RUSSELL · PIONEERS IN HEAT TRANSFER APPARATUS

G-R

HEAT TRANSFER APPARATUS Fully Serves a Stabilizer In This Installation

As shown in the illustration on the adjoining page, all the heat transfer apparatus required for the stabilizer at this representative refinery is of G-R design. The G-R units include cooler, exchanger, reboiler and condenser, and also naphtha side-cut cooler.

Many additional G-R units, not shown in the illustration, were also installed for other services here; for this refinery, like hundreds all over the country, standardized on G-R Heat Transfer Apparatus to assure most effective heat exchange and recovery throughout the plant.

Whatever may be *your* heat transfer requirements . . . whether standard or special . . . investigate G-R designs. The unequalled range of G-R apparatus, including both finned tube and bare tube heat transfer surfaces, provides an exactly suitable design for every service. Write for descriptive bulletins on units for services in which you are interested.

THE GRISCOM-RUSSELL CO.
285 MADISON AVE., NEW YORK 17, N. Y.

TYPICAL DESIGNS OF G-R HEAT TRANSFER APPARATUS

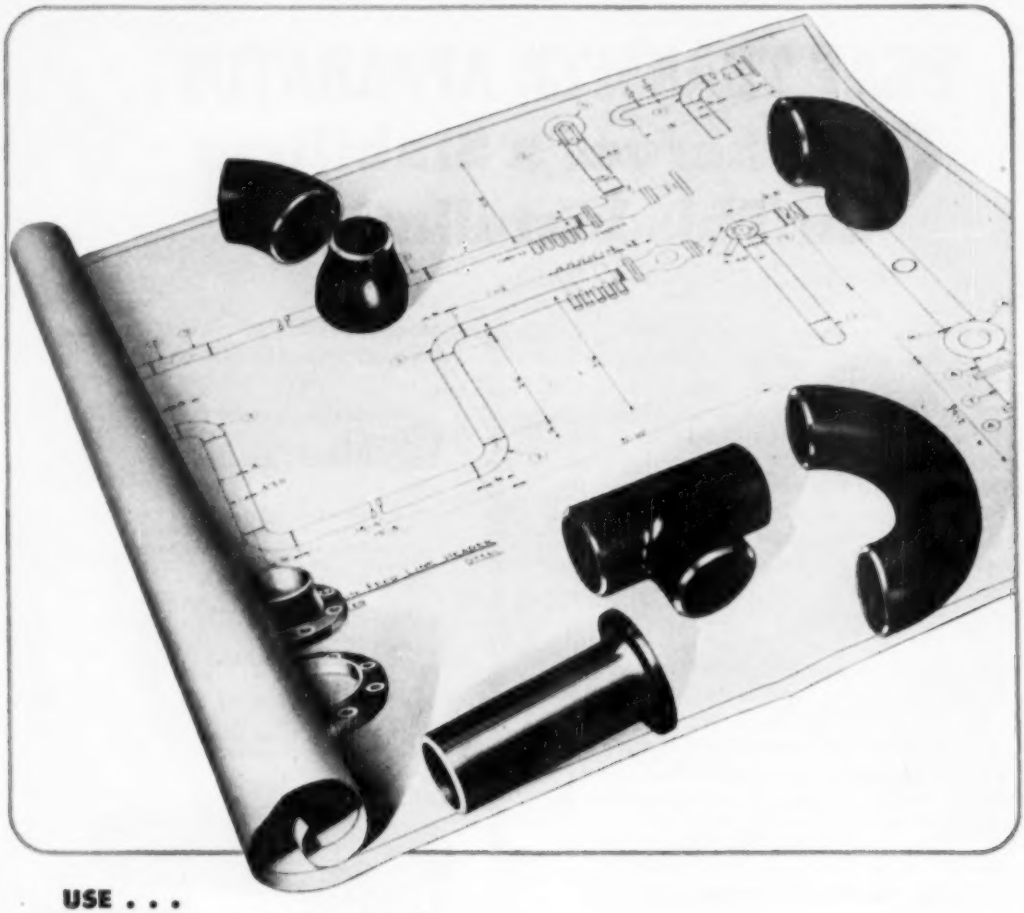
G-R Tubular Exchanger, available with many different designs of stationary and floating heads, and with exclusive service features

Sectional drawing of the G-R Twin G-Fin Section, the heat exchanger with a greater range of applications than any other design on the market

One of the designs of G-R Reboiler, available with bare tubes or K-Fin elements.

GRISCOM-RUSSELL

TO DO A BETTER PIPING JOB . . .



USE . . .

GLOBE PRECISION PROCESS SEAMLESS WELDING FITTINGS

When you specify and use Globe Welding Fittings you have the product of an organization with unusually broad metallurgical experience. Globe's precision-process method of production reaches back to the manufacture of the Globe seamless tubes themselves which are the "raw material" of Globe welding fitting fabrication.

GLOBE STEEL TUBES CO., Milwaukee 4, Wisconsin

Chicago • Minneapolis • Cleveland • Detroit • New York • Philadelphia St. Louis • Tulsa • Houston • Denver • San Francisco • Glendale, Cal.

Producers of Globe seamless stainless steel tubes — Gloweld welded stainless steel tubes — carbon — alloy — seamless steel tubes — Globeiron seamless high purity ingot iron tubes — Globe Welding Fittings.

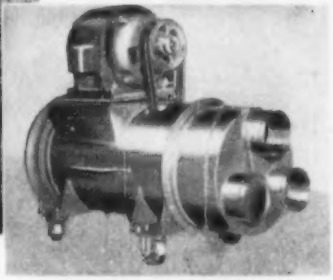
Send for the Globe Welding Fittings Catalog—and look to Globe as a preferred source of supply.

This 22-Foot Hartzell Cooling Tower Fan Can Give You .... 1,250,000 C.F.M.

Shown on the Hartzell test stand is the new Hartzell 22-foot Cooling Tower Fan. Blades are of Hartzite plastic, which has proved itself to refiners so convincingly on Hartzell fans up to 20-foot diameter. It was run continuously at 125% of its rated speed on test; stresses developed were 55% greater than are encountered in service. It delivered 1,250,000 cfm at 180 HP.

This truly great new fan, on which we are now making deliveries in the sequence in which orders are received, will give you maximum cooling power per cubic foot of tower. Power cost per cubic foot of air moved is relatively low.

If you build or buy cooling towers using fans of 3' to 22' size, specify Hartzell. If you've had trouble with fans in existing towers, replace with Hartzell. Your troubles will end!



PORTABLE BLOWER CLEARS FUMES FROM TANKS

Shown above is a Hartzell Vaneaxial Blower "on casters." Easily lifted by two men, compact, powerful. Specially mounted by Hartzell to clear fumes from gasoline tank trucks before and during interior welding repairs. Each of three portholes, any or all of which can be used at one time, delivers approximately 500 cfm through a 15-foot long 5" hose. End assemblies easily reversible for exhausting or blowing. Other capacities can be produced.

CLIP AND MAIL COUPON NOW FOR INFORMATION

HARTZELL PROPELLER FAN CO.
Div. of Castle Hills Corp.
PIQUA DEPT. K OHIO

Name_____
Company_____
Street & No._____
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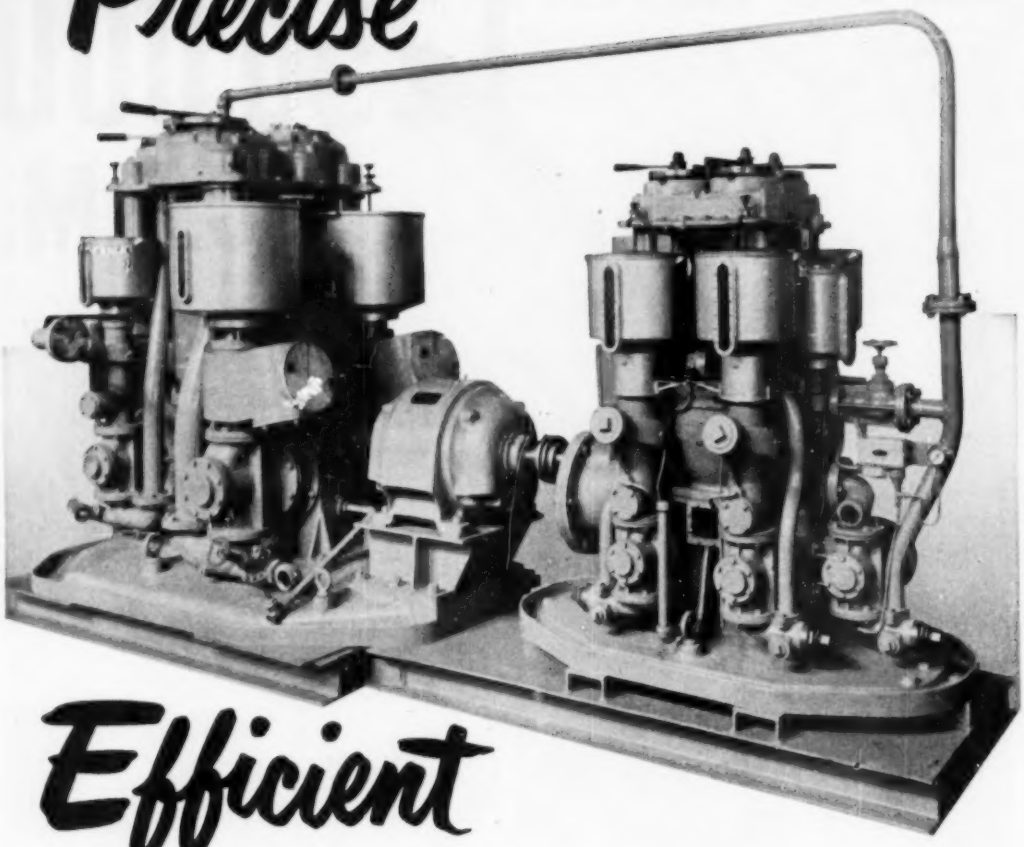
PROPELLER-TYPE FANS AND BLOWERS — ROOF VENTILATORS — UNIT HEATERS • ENGINEERING OFFICES IN PRINCIPAL CITIES

Precise



Efficient

The oil blending machines shown here are examples of the precise and efficient craftsmanship available at Sun Ship. The versatility of our organization and the diversity of our facilities enable us to build with equal success other refinery equipment, chemical plant and industrial machinery; tankers, cargo and passenger vessels. Here, too, are facilities for dry docking and for making all kinds of marine repairs.

Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE (SINCE 1916) CHESTER, PA.

25 BROADWAY • NEW YORK CITY

Two or three 12 x 36 x 20 duplex horizontal steam driven opposed, single-stage Worthington Vacuum Pumps in the Lake Charles, La., plant of the Cit-Con Oil Corporation. Other Worthington units at this plant include four additional vacuum pumps and three centrifugal propane refrigeration units, as well as 14 double pipe scraped surface type exchangers and 12 chillers.

The Worthington Vacuum Pumps shown here are used in conjunction with rotary filters in the dewaxing of petroleum lubricating oil stocks.

OVER $500,000 WORTH OF WORTHINGTON EQUIPMENT IN LAKE CHARLES PLANT

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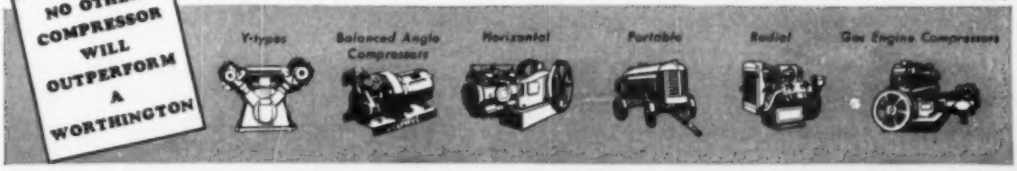

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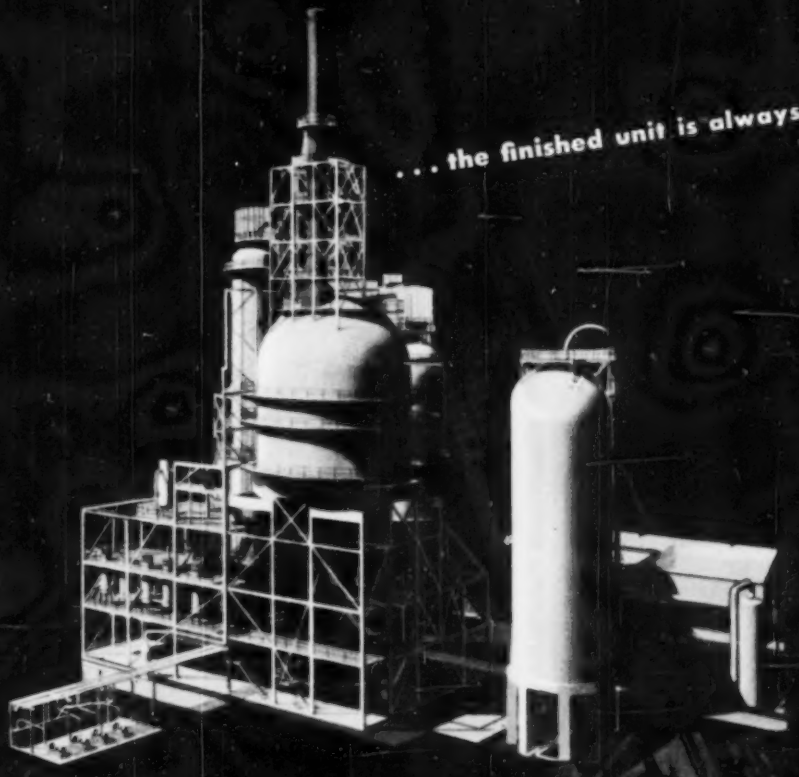

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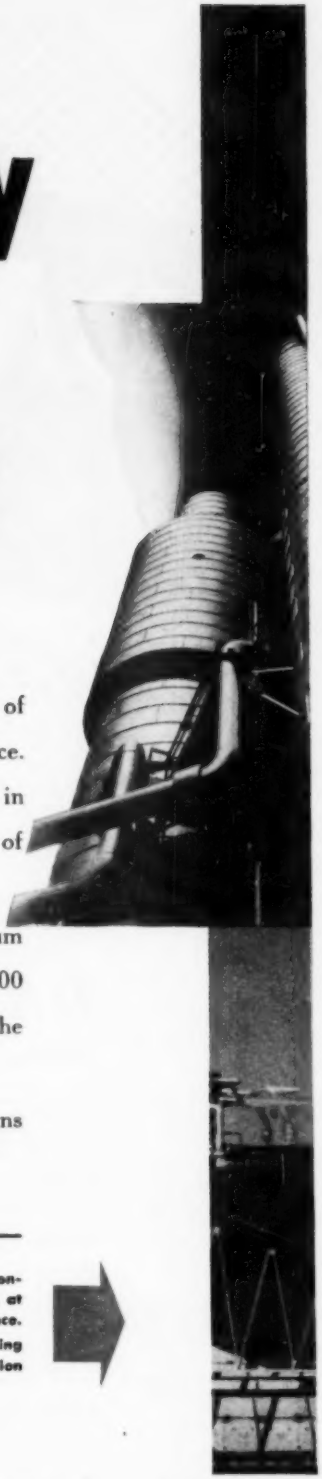

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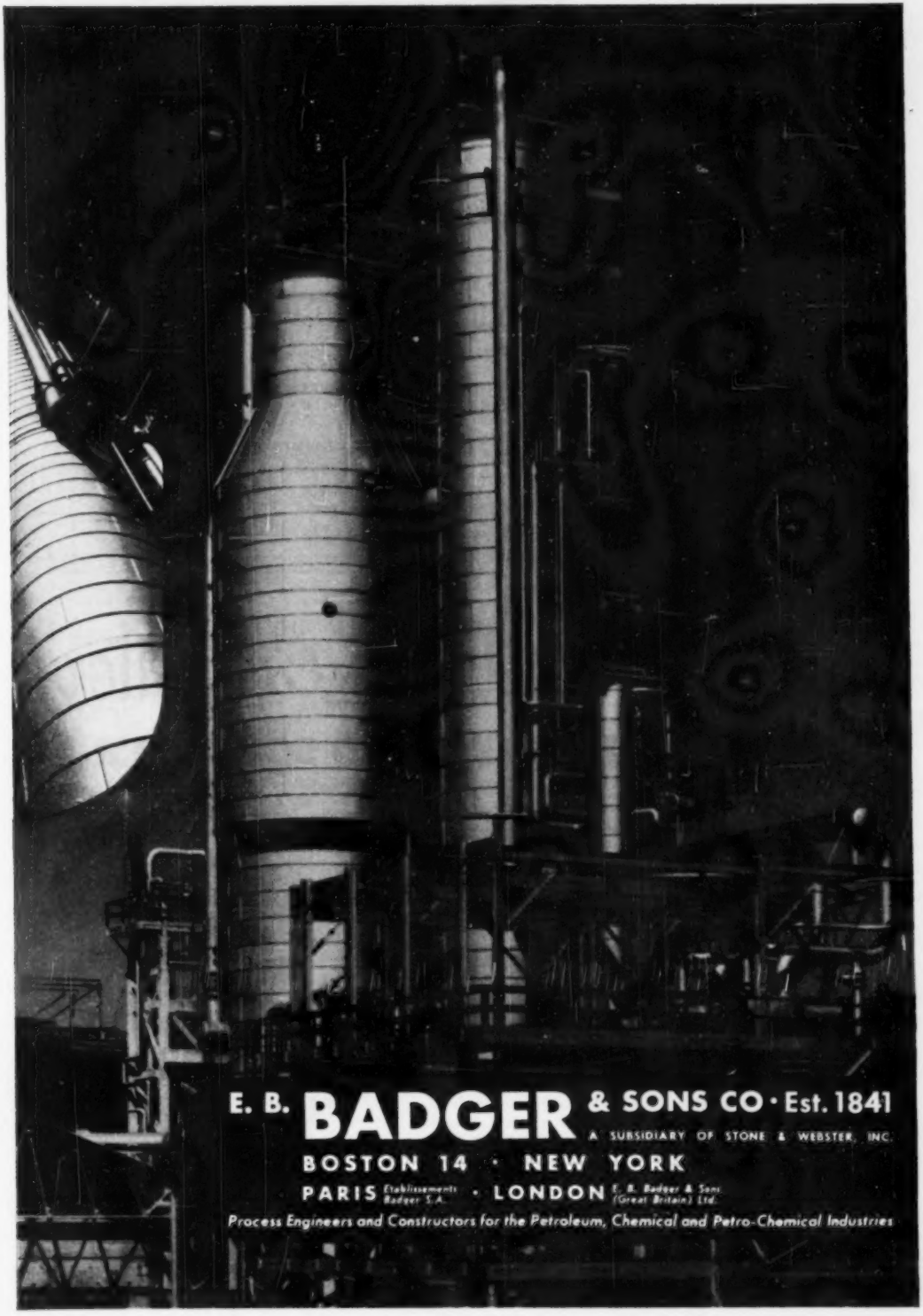
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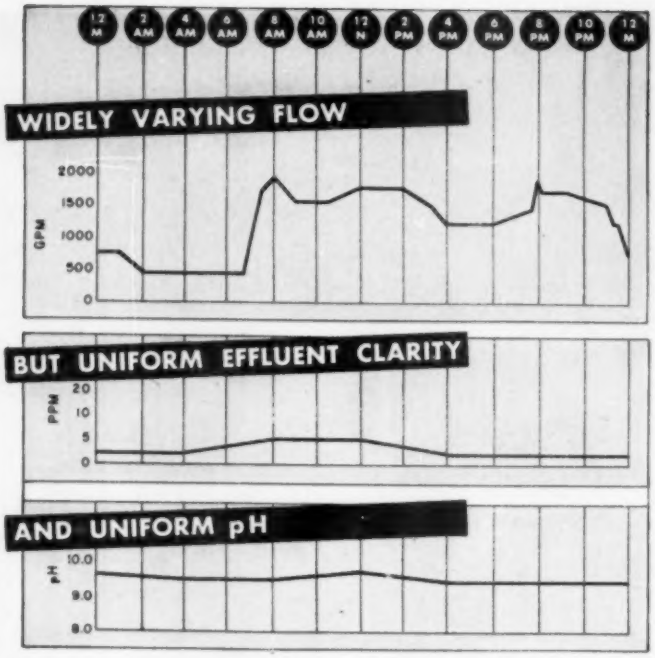

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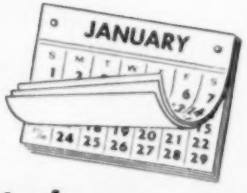

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PETROLEUM PROCESSING
DECEMBER, 1950

What's Ahead for Petroleum In the Energy Markets?

By 1960 It Is Expected That:

- **Total domestic energy demands may be increased by one third, to nearly 43,000 trillion BTUs annually.**
- **Refinery runs of close to 7,000,000 b/d will be required to meet oil's portion of these demands.**
- **Stationary uses of oil (heating and power generation) will have grown at a faster rate than the traditional transportion uses.**
- **Higher middle distillate yields (28-30%) may be required, with lower residual yields and no change in gasoline yields.**

By ***CHESTER F. SMITH****
Vice President, Standard Oil Co. (N. J.)

PETROLEUM is used primarily as a source of energy. Hence, to place the future petroleum industry in its proper perspective, it is first necessary to consider total energy requirements.

It may be a surprise to some people to learn that oil and gas alone have supplied all of the net increase in energy requirements in this country for the past 30 years. By itself, oil has grown from the point where it provided about one-seventh of this nation's total energy requirements in 1920, to its present position of two-fifths of the total.

Because we are primarily interested in oil, it will be convenient to deal with the total energy market in two separate categories—first, the so-called specialty and transportation uses, the latter including land, water, and air travel, where oil enjoys a distinct advantage over the other forms of energy; and, second, the stationary uses of energy such as power generation and heating, where alternate forms of energy may be more readily interchanged. When we have determined the magnitude of total energy demands in each of these categories, we will be in a better position to appraise the size of the potential oil market.

Basic Factors

Recent estimates by the Bureau of Census predict a population of 169 million in 1960, a growth rate of 1% per year. The ever-increasing productivity of this growing population will be founded mainly upon increasing utilization of mineral energy, making possible more and more substitution of mechanical energy for human energy. A projection of historical trends indicates that economic activity may advance by about 25% in the next 10 years. Partly because of accelerated mechanization, the use of energy may increase as much as a third despite some further improvements in efficiency.

Against this background, the prediction of petroleum developments is further dependent upon engineering progress, including possible new sources of energy, and on the future price relationships of each of the competitive forms of energy.

Probably the greatest impact of efficiency will be in the field of railroad transportation where almost all of the traffic is expected to be handled by diesels in 1960. Some observers believe the rails may be from 85% to 90% dieselized 10 years hence. The gas turbine, its only likely competitor, has shown little, if any, efficiency advantage even over present stationary installations for power and heat generation. In railroad use its efficiency may approach that of the diesel, but the savings would not appear sufficient to encourage important replacement of diesels by 1960. We must remember that for many years the diesel was known to have a very large advantage over the steam locomotive. Yet its introduction was slow, in view of the long life of railroad engines, and the large investments required.

It is possible—but I do not think probable—that new sources of energy may come importantly into the picture. Three potentially important sources that are still in the experimental stage are the heat pump, solar energy, and atomic energy.

In the case of the heat pump, which uses heat stored within the earth, the first investment cost is estimated to be nearly three times that of a conventional type heating unit. Moreover, the process is uniquely dependent upon a source of cheap electric power in an area where fuel is re-

* Principal portion of the paper "Opportunities for Petroleum in the Energy Markets of the Future" presented by Mr. Smith at the annual meeting of the American Petroleum Institute in Los Angeles, Nov. 13-16.

TABLE 1—Sources of Energy Used in the U. S.

(1,000 Trillion BTU)

	Hydro-Power	Natural Gas	Coal	Oil	Total
1940	0.9	2.8	12.7	7.8	24.2
1949	1.6	5.8	12.2	12.4	32.0
1960 (estimated)	2.3	9.8	13.6	17.2	42.9

latively expensive. For these reasons, it is doubted that heat pumps will reach the mass market in the next decade.

It has been estimated that the fuel saving due to the use of solar heat would take 15 to 20 years to pay off the investment in the heat collecting equipment required. That would still leave the investment for heat storage, distribution, and an auxiliary fuel system to be covered. The large investment required will also impede the development of solar heating.

Lastly, the outlook for the use of atomic power in certain types of installations appears promising, although not immediate. Due to both economic and technical limitations, there is little likelihood of its use in small installations, such as in domestic heating, motor vehicles, or railroad locomotives. The most effective application would be in large stationary power p'ants or large marine equipment. In any event, the development of general purpose power-producing reactors is not anticipated in the next decade or so.

Future trends in the relationships among prices of competitive fuels could prove to be of importance equal to that of engineering developments. In the case of transportation, the differences in the efficiencies among competing fuels is so great that small differences in the fuel cost to the consumer should not have much influence on the types of fuel used. However, in such uses as the generation of power and heat, price relationships of fuel are extremely important. Should the relative price of any one of our major fuels get very far out of competitive alignment, it would result in a loss of outlet for that fuel. There is no clear reason to believe that such a limitation will develop over the next 10 years. Accordingly, as a basis for thinking about future developments, it is best to assume that past competitive price relationships will be continued.

Over the period of the last 50 years, the rate of increase in energy consumption has averaged 1¾% per year. I have recently examined a detailed estimate of future energy consumption. Highway vehicles, aviation, vessels, railroads, specialty products, space heating, utility power production, and industrial and miscellaneous uses, according to this study, may require about 43 thousand trillion BTU in 1960. This would represent a compounded rate of gain of 2.7% per year during the forthcoming decade.

That would be a higher rate of gain than the 50-year average, but it would be considerably under the 3.9% per year experienced in the past decade. Interestingly enough, there was essentially no gain in energy consumption during the decade of the thirties, due largely to the depression.

Changing Pattern of Demand

Because of the installation of the more efficient diesel locomotives, the consumption of energy for total transportation and specialty uses may not increase very greatly from 1949 to 1960—perhaps only about ½% a year. That is a very important conclusion. It is a far slower rate of gain than the rise of 2.3% per year between 1937 and 1949. Expressed in another way, transportation and specialty uses may decline from 1/3 of the total energy market in 1937 to ¼ by 1960.

By contrast, the use of energy in heating and power generation may increase even faster in the future than it has in the past. The continued rapid increase in fuel use anticipated by electric utilities is part of the explanation.

The slower prospective rate of growth in transportation highlights that portion of the energy market to which the oil industry has traditionally looked for the bulk of its demand. In 1937, these uses accounted for 70% of oil consumption—in 1949 they were down to 64%, and during the next decade a further decline to below 60% is anticipated.

Thus, if the petroleum business is to continue its accustomed rate of growth, it must continue to look increasingly to the stationary uses. Of course, this is what has been happening—in 1937, about 13% of the energy used in stationary installations came from oil. By 1949, it reached 20%. Competition from natural gas may limit somewhat the future rate of growth of oil in stationary uses.

One use of energy particularly should be given increasing attention by the oil industry, it seems to me, and that is power generation by utility companies. This has shown a tremendous rate of growth to date, essentially doubling every decade. In terms of energy input requirements, this has meant a compounded growth of 5% per year since 1937, and this rate is expected to continue through 1960.

Just as oil has had an overwhelming advantage in the transportation field for the past several decades, natural gas and hydroelectric power, I believe, will have an advantage in stationary uses for years to come. Their share of tomorrow's energy market may be limited only by their availability to the consumer.

Apart from these two sources of energy, the other two major sources are petroleum and coal. There will be room for each of these to grow, I believe, even after allowing a priority position for gas and hydro power.

Perhaps the best way to see the relative growth that might be available for each of these major fuels is to express them in terms of comparable heat units—trillions of BTU per year. Table 1, that part of the total energy market supplied by oil and coal, respectively, has been estimated after a study of the several energy-consuming industries, and with the thought in mind that the competitive prices of these two fuels will maintain about the same relationship to each other as in the past.

Notice that all sources of energy are expected to increase in volume by 1960, with natural gas showing the greatest gain percentage-wise. Even in the face of stiff competition from oil and gas, the volume of coal required is expected to hold its own, and perhaps increase somewhat.

Oil Requirements in 1960

Now to take a closer look at oil. Domestic demand in 1960 may rise to something over 8,000,000 b/d from the level of 5,800,000 b/d in 1949, an average increase of just a bit under 3.0% per year. You may recall that this rate of increase is about the same as that for total energy mentioned previously. Slightly over half of the icreased volume should result from higher requirements for the generation of heat and power. Thus the demand for heating fuel, including heavy fuels, should continue strong throughout the period.

Oil requirements for transportation other than highway vehicles are expected to increase by only a nominal amount—about 1% per year up to 1960. The rapid growth anticipated for the more efficient diesel engine in railroad transportation, together with the reduced outlet for residual fuel-fired steam engines, may result in only a slight increase in total oil consumed by railroads.

Fuel requirements for highway vehicles may increase by about 2½% per year averaged over the next decade. The growth in motor fuel demand may be roughly proportionate to increases in vehicle population, since increased mileage per vehicle is expected to be just about offset by improved fuel efficiency. The average number of vehicles o. all kinds on the road may reach 50 million by 1960. There were about 40

million in 1949. Slightly over 41 million may be passenger cars in 1960 compared to 34 million today.

Compression ratios will continue to increase gradually with the maximum level of any make of car not expected to exceed about 12 to 1. Such cars will give considerably improved engine efficiency compared to today's average new cars, the improvement being about 35%. Some of this improved engine efficiency will probably be used to give better car performance rather than higher miles per gallon. It is expected that cars of compression ratios in the neighborhood of 12 to 1 will be produced on a substantial scale before 1960. Such cars will naturally require higher octane gasolines than are being produced today. The production of gasoline to satisfy the needs of such cars appears feasible with processes now developed, and will involve the use of catalytic reforming of virgin naphthas along with more extensive application of catalytic cracking.

Refinery Runs and Product Yields

What is the effect of this demand as I have outlined it upon refinery runs and product yields? The demand for middle distillate fuels on a competitive basis is expected to grow more rapidly than that of other petroleum fuels, due largely to the growing numbers of heating oil burners, and to increased dieselization. As a result, an annual average yield of these fractions including kerosine, of 28 to 30% may be required in contrast to a yield in 1949 of 23%. An annual average yield approaching 30% implies a still higher winter yield, unless we learn in the meanwhile the advisability of carrying larger average inventories of distillates during the slack summer season. In effect, this increase in distillate yields may well come from a reduction in residual fuel yields, since the yields of gasoline and other products may remain essentially unchanged.

As you all fully appreciate, the pattern of future runs and yields depends heavily upon whether, and how, we are to supply an adequate volume of middle distillate and residual to compete in the stationary energy field. If the future crude and products price structure continues to favor the conversion of residual fuel to lighter products, it is obvious that domestic residual yields will decline further, and residual imports would have to be increased if demand at competitive prices is to be satisfied. Only a moderate decline in average residual fuel yields, for example, to 17% on domestic crude runs of 7,000,000 b/d in 1960, would require residual imports of about 600,000 b/d. Should lower residual yields develop, each 1% decline in yield would necessitate a further increase of about 80,000 b/d in residual imports. In 1949, with runs of about 5,300,000 b/d, and residual fuel yields of 22%, about 200,000 b/d of residual imports were required to satisfy demands at competitive prices.

Some people have argued that residual imports should be restricted and the use of petroleum concentrated in the transportation and specialty markets, only competing in the heat and power generation market to the extent of the by-product fuel that results from runs to maximize yields of gasoline and specialty products. However, if this should be done, it seems to me, many customers who now have a choice between two or more fuels would be denied that choice. The growth of the oil market would be limited and our national security could suffer a real setback. There would be less incentive to develop adequate reserve supplies, and the quick imposition of emergency military requirements would necessitate a crippling reduction of civilian transportation, needed to support a mobilized civilian economy.

On the other hand, if competitive prices permit petroleum to develop in competition with alternative fuels in the power and heating market, as well as in transportation and specialty uses, the industry will not only be able to provide larger base facilities because of greater growth, but it will also be able to offer a reservoir of supplies withdrawn from uses in which alternative fuels could be substituted. In addition, a gradual increase in reliance upon foreign supplies would encourage the development of greater reserve capacity in Canada and the Caribbean area for use in time of emergency. The recent increase in Venezuelan crude production as a result of the Korean war offers current evidence of the wisdom of such a policy, as does the fact that the navy, during World War II, was primarily dependent upon the Caribbean for its fuel oil needs.

Crude Availability

The anticipated levels of demand during the next decade indicate the need for increasing rates of crude oil and light hydrocarbon production in this country, reaching a level for crude alone of around 6,500,000 b/d in 1960. This year we will produce about 5,400,000 b/d. The 1960 requirement would be even greater if it were not for an anticipated increase in refinery yields of overhead products. I am confident these crude oil needs can be met. Indeed at that level, it is expected that there will still be a desirable working reserve in 1960 perhaps in excess of half a million barrels per day.

If we attempt to look into the more distant future, there will come a time when petroleum supplies will be limited in relation to demand. As has been pointed out, the feasibility of production of liquid fuels from oil shale or by synthesis from natural gas or coal has been effectively demonstrated. Such methods are not economically justified today, but I feel that their commercial development will come under the influence of normal competitive forces when they are needed.

Conclusion

Several points emerge from this analysis that I want to present for your consideration:

1. The transportation field, where oil enjoys unique advantages, seems likely to become a less rapidly growing market from the standpoint of energy requirements.

2. The largest potential for future oil growth thus appears to lie in the stationary power and heat field. While convenience in use is of some importance here, price competition with other sources of energy is the dominant long-term factor.

3. There should be adequate supplies of oil to cover expansion in both of these fields for the decade ahead, and, in addition, for many, many years more.

4. The industry is faced with the problem of meeting moderate increases in demands for residual fuel during a period when refiners' incentives will call for progressively lower fuel yields. Product prices and fuel oil import policies will determine whether this demand is to be satisfied. Both economic and national defense considerations indicate that it should be satisfied.

In summary, I foresee the possibility of a total energy requirement in the U. S. by 1960 of about 43 thousand trillion BTU, with some 40% of this coming from oil. The introduction of new sources of energy is not expected to contribute an important share of this total by that time. Some 50 million vehicles are expected to be on our highways, and railroads will be near complete dieselization. However, transportation and specialty uses may consume only one-fourth of the total energy requirements.

Refinery runs should be close to 7 million b/d with higher middle distillate and lower residual fuel yields. Little or no increase in gasoline yields is expected.

As far ahead as I can see, adequate supplies of liquid fuel should be available for all of our customers. The pattern of demands made by our customers may change somewhat. Fortunately, our customers will become more numerous. We are a flexible and progressive industry—and as long as we stay that way—I have no concern about our ability to take in stride the refining and marketing problems that lie ahead.

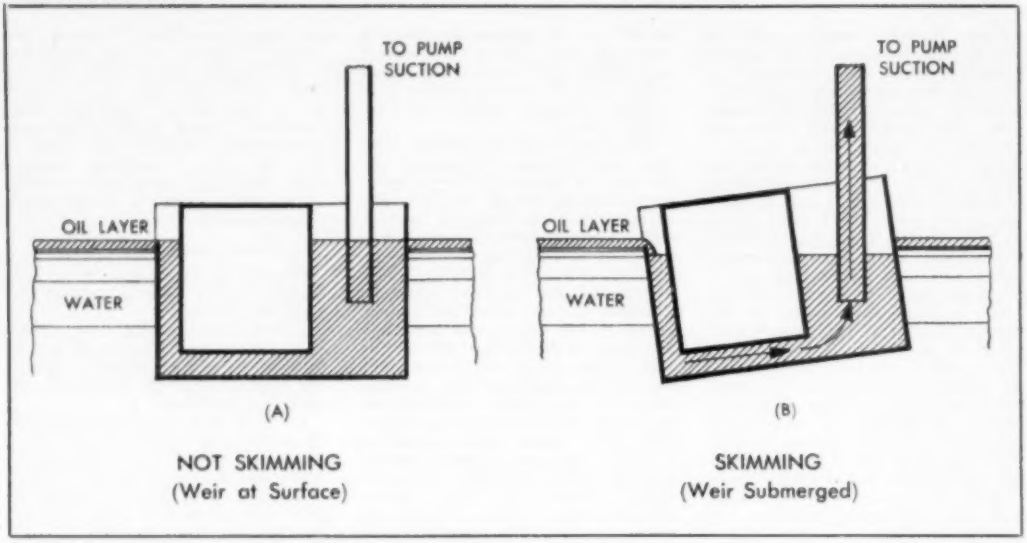


FIG. 1—SIMPLE TURN OF VALVE on pump suction regulates amount of tilt of skimmer and also depth of weir below surface of oil layer

How Self-Adjusting Skimmers Improve Operation of Waste Separators

Successful full-scale installations of automatic floating skimmers in several Esso Standard Oil refineries have 1) reduced the man-hours normally required to operate a conventional design skimmer by eliminating the need for constant manual adjustment of weir height to meet changes in surface level, 2) minimized the fire hazards, and 3) lessened evaporation losses usually occurring when large oil-covered areas are exposed to the atmosphere. Over 40 of the new-type skimming units have been installed by Esso during the past two years.

By W. O. SMALL, Coordinator, Oil Conservation Activities, Esso Standard Oil Co., Baltimore, Md.

IMPROVED operation of waste separators is being accomplished in refineries of the Esso Standard Oil Co. by use of a self-adjusting floating skimmer. The device positions its skimming edge automatically to correspond with variations in skimming rate.

As a result, the operators of the oil-water separator can regulate the depth of the inlet weir for any given oil layer thickness simply by the turn of a valve to control the rate at which liquid is removed from the skimmer. The operating principle of the device has been employed in a number of design variations for over two years, during which time more than 40 units have been installed in Esso's refineries.

It is very important that the separated oil layer be removed promptly and efficiently in the operation of a refinery waste separator, not only to minimize the fire hazard but also to reduce the evaporation losses associated with exposure of large oil-covered areas to the atmosphere. Skimming might be accomplished rather easily were it not for the continual variations in surface level, which require some method of keeping the skimming weir properly located with relation to the oil layer.

Esso's self-adjusting skimmer was developed as a result of efforts to improve on existing equipment available for keeping separator surfaces clear of oil accumulations.

Problems in Existing Equipment

The conventional manually-adjusted skimmer usually consists of a trough or slotted section of pipe suspended at the separator surface by means of jack screws to permit raising or lowering the device as the surface level varies. Oil entering the skimmer may be removed either by gravity flow to a collecting sump or by direct connection to the suction of a skimming pump.

With this arrangement, considerable effort and attention on the part of the operator are necessary to maintain the skimmer at the proper elevation, particularly if a number of units are in service at the same time. Excessive amounts of water obviously will be admitted into the skimmers when the separator level rises without a corresponding adjustment, while skimming ceases entirely if the skimmers are not reset to accommodate a drop in separator level.

Several types of skimmers have been devised which make use of a float to support the skimming edge at the surface without the necessity for constant manual adjustment.

However, certain operating difficulties prevented their general acceptance.

Because of the symmetrical arrangement of the skimming edge with respect to the float compartment, the earlier floating skimmers had a tendency to raise the skimming edge above the surface level upon the removal of liquid from the skimmer instead of depressing it so that liquid could flow into the skimmer. This action often caused the skimmers to empty themselves, thereby admitting air into the pumping system. Operators quite naturally resorted to the practice of adding sufficient additional weight to keep the weirs submerged under all conditions. With the skimming edge held too far below the surface, it was impossible to skim satisfactorily, except in the case of an abnormally thick oil layer.

On the basis of these experiences with manually positioned skimmers and the earlier floating types, it appeared that a definite improvement might be achieved by designing a floating skimmer having the additional characteristic of automatically locating its skimming edge to correspond with variations in skimming rate. The self-adjusting feature was made possible by introducing the nonsymmetrical design now employed in the new skimmer, as illustrated in Fig. 1 and described below.

The New Skimmer

The basic elements making up this type of skimmer are the float and the two open compartments on opposite sides of the float through which the skimmings flow. The float consists of a rectangular pontoon having sufficient bouyancy to support the weight of the device. On one side of the float is the inlet section into which the surface layer of oil flows over a weir. Connected to this section by one or more passages is the suction section lying along the other side of the float and from which the oil is removed by a line leading to the skimming pump. It will be noted that this line extends below the surface of the liquid to the rear of the float but does not interfere with the vertical travel or the tilting movement of the skimmer.

The compartment to the right of the float in Fig. 1 is several times wider than that of the inlet section to the left. This feature creates enough tilting movement opposing the stability of the float to rotate the skimmer slightly about its longitudinal axis, thus depressing the weir below the surface even though the skimmer itself actually rises because of the increased buoyancy when liquid is withdrawn from the skimmer.

Fig. 1B illustrates the operation of this principle. At the higher pumping rates the weir is depressed further, thereby admitting more of the separator surface layer into the skimmer. Decreasing the pumping rate, on the other hand, allows the skimmer to take in slightly more liquid than is being removed, and the weir tends to rise as the skimmer tilts back toward its original position. In this manner the weir constantly finds the correct depth corresponding to the pumping rate thus making it possible to control the depth of cut by regulating the skimming pump.

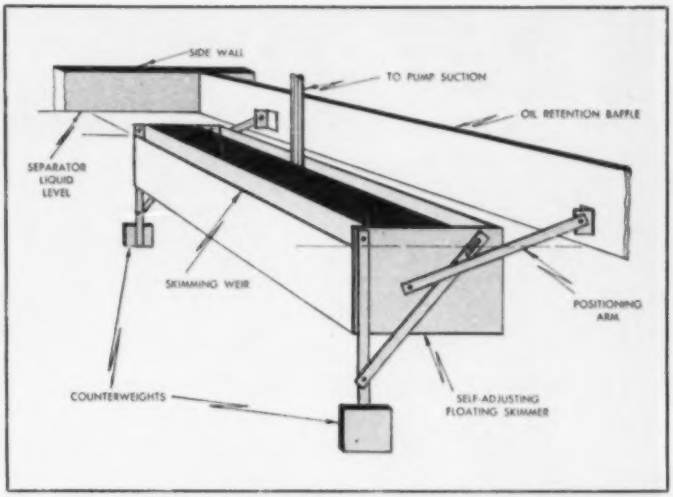
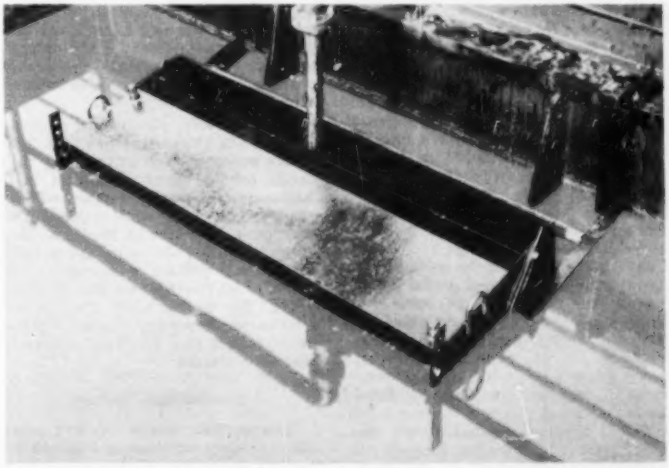


FIG. 2—SKIMMER CONSTRUCTION is shown in this perspective drawing

Several Advantages Cited

There are several advantages to the type of skimmer described above. The floating feature eliminates the need for constant manual adjustment of weir height to meet changes in the separator surface level. Automatic positioning of the weir with reference to the skimming rate eliminates the possibility of breaking suction with any pumping rate normally encountered. It is only necessary for the operator to choose a skimming rate suitable for the thickness of the oil layer to be skimmed and set the pumping rate accordingly.

Of course if the skimming rate is too high for the amount of oil on the surface, the weir will dip too deep and water will be taken into the system. The operator must observe conditions from time to time and regu-



TYPICAL FLOATING SKIMMER installation showing suction pipe and positioning arm arrangement

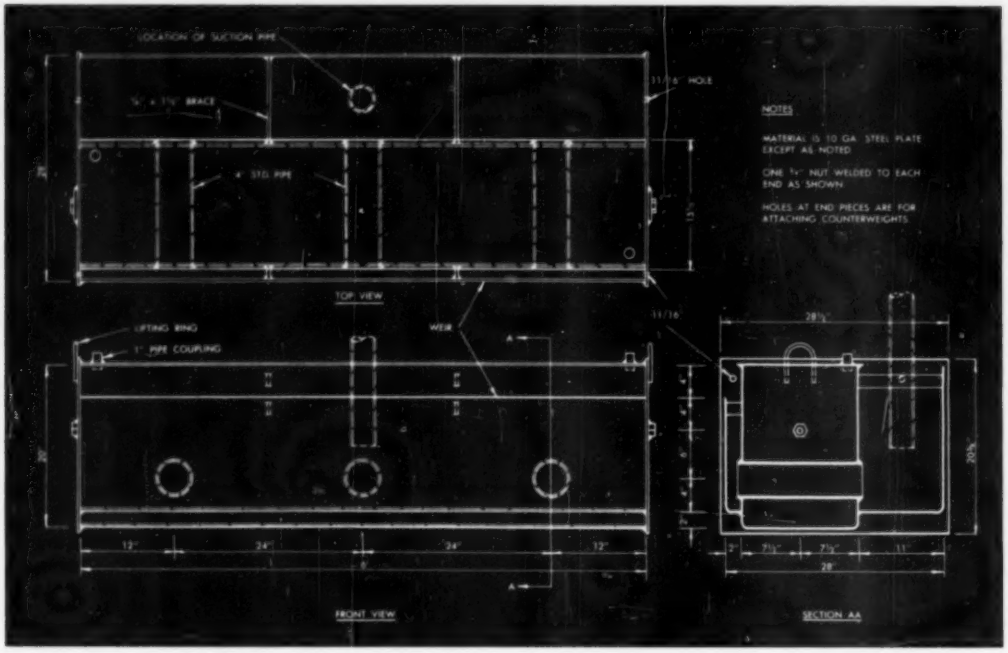


FIG. 3—CONSTRUCTION DETAILS of the six-foot model skimmer

late the pump for good skimming with minimum water intake. However, this task is simplified since he is relieved of continually having to make changes to skimmer settings to compensate level and rate variations.

Self-adjusting skimmers, employing the principle just described have been constructed in lengths ranging from five to eighteen feet, with the six to ten foot models predominating. Variations in design details include several methods of providing for flow passages, adjustment of counterweights, means for keeping the skimmer in place, etc. Since all of the models installed up to the present time have operated more or less satisfactorily, it is difficult to determine just which of the various design features should be incorporated in a standard design.

The first and a number of subsequent models were constructed in two pieces; the float, and an outer box making up the weir, liquid passages, and the suction section. Tilting characteristics of the two-piece skimmers were adjusted by shifting the position of the float within the outer box.

Once having established the optimum float position, a number of units were fabricated in one piece with a single bottom and liquid flow around the ends of the float.

Still another version is that shown by Fig. 3, in which the liquid flows from front to back through several pipes passing through the float. Tilting characteristics of the fixed-float models can be varied by changing the vertical position of the counterweights shown in Fig. 2, thus raising or lowering the center of gravity until it falls between the points of excess and insufficient stability. This adjustment is not critical, and once determined at the time of installation should require no further change.

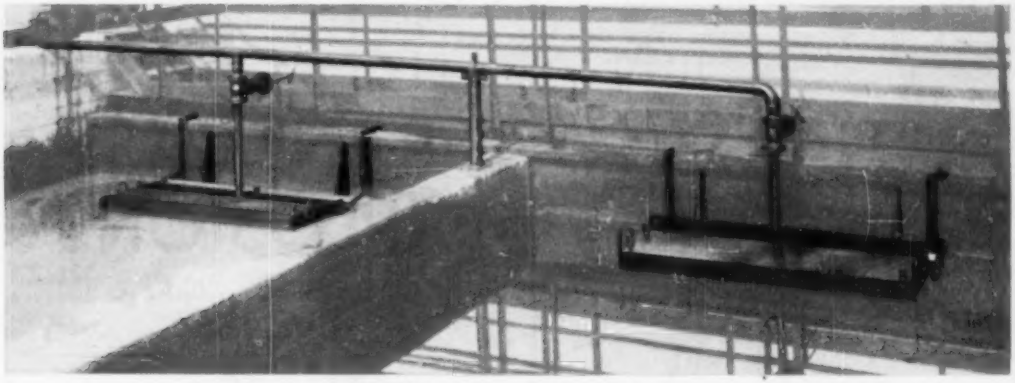
Ordinary steel plate approximately ⅛ in. thick (10-gauge) has been generally accepted as a satisfactory material for the construction of self-adjusting floating skimmers. It is readily cut, bent and welded. The first unit, which was made of this 10-gauge plate, shows no appreciable indication of pitting or corrosion after being in service for two and one-half years. The use of alloy steel is not felt to be necessary, except in the case of separator handling unusually corrosive waters.

Construction Details

Construction details of a typical self-adjusting skimmer are shown in Fig. 3. This model is six ft. long and 28 in. wide. The sides and bottom of the float were formed by bending a single piece of 10-gauge plate and welding on another piece for the top. After adding the extended end pieces to the float, holes were cut in the sides to receive the sections of four-in. pipe forming the liquid passages. Two one-in. pipe couplings in the top of the float were plugged after testing for leaks in the float seams. Having established the tightness of the float, the remaining two bent plates were welded in place to complete the weir and suction sections. Lifting rings at each end of the skimmer facilitate handling during fabrication and installation. A nut welded to each end piece as shown serves as the pivot point for attaching the positioning arms. A bolt hole is punched in the top corner of each end piece for purpose of fastening the adjustable counter-weights in place.

This particular model requires a weight of about 70 lbs. suspended approximately one ft. below each end of the skimmer and several inches forward of the float centerline to make the skimmer float in the position shown in Figs. 1A and 2.

Installation of the skimmer consists of placing it in the separator with the pipe from the skimming manifold extending into the suction section. Positioning arms reaching from clips attached to the oil retention baffle to the nuts on the ends of the float serve to keep the skim-



TWO SIX-FOOT SKIMMERS installed on Baltimore refinery separator, showing suction piping and skimming pump

mer in place and prevent it from touching the suction pipe. After final adjustment of the weights the skimmer is ready for operation.

If only one skimmer is operated from an individual pump, the operator can control the depth of cut and the rate of skimming by regulating the pumping rate so that the weir does not dip below the oil layer. Observation from time to time may indicate the advisability for changing pump speed if it is desired to skim more rapidly or more slowly. With separators having a number of skimmers connected to a common manifold the individual units are controlled by regulating the suction valves to obtain the optimum oil removal performance at each skimmer.

Self-adjusting skimmers are particularly advantageous in cases where the operator must leave the skimming equipment running while attending to other duties elsewhere, since the possibility of losing suction due to a drop in separator level is practically eliminated. Heavy emulsions or scums often catch on the edge of manually regulated skimmers, thereby reducing the inflow and causing the system to break suction. The self-adjusting skimmer, on the other hand, automatically dips deeper until the scums are washed over the weir.

Discussion this far has been confined to removing oil from separators where surface level variations do not exceed three or four in. and it is possible to utilize fixed suction pipes extending into the liquid-filled sections of the skimmers. To meet wider fluctuations in level, suction pipes have been provided with flexible joints to permit raising or lowering them as neccessary. In one case a floating skimmer was installed in a body of water subject to tidal changes. This unit was equipped with a swing pipe connection attached directly to and supported by the skimmer itself. Satisfactory performance resulted over the maximum vertical range of about 6 ft.

May Simplify Other Equipment

Installation of a self-adjusting skimmer may possibly result in simplifying certain separator equipment. To skim the inlet compartment of one particular separator formerly required two manually regulated skimmers flowing by gravity to a large sump from which the oil was pumped to storage. The amount of attention needed to keep the skimmers at the proper level and difficulty with plugging of the inaccessible flow lines made this a time consuming operation. After installing a single self-adjusting unit in the forebay of this separator it was found possible to abandon both of the old skimmers and the gravity flow sump. Oil is now pumped directly from the skimmer to the storage tank, and maintenance of the system is facilitated because all parts are easily available for cleaning or repairs.

In conclusion, it is believed that the self-adjusting floating skimmer provides an improved method for removing oil from separators where level variations make manually adjusted skimmers difficult to operate satisfactorily. This is evidenced by the fact that more than forty units are being used in several refineries. By automatically compensating for level and pumping rate changes, this type of skimmer greatly reduces the amount of operator attention required. Construction, installation, and maintenance are relatively simple. There is also the possibility of reducing the cost of new installations by eliminating the need for sumps and inaccessible gravity flow lines. Further improvements in design will probably be made as the experience of the various plants using this skimmer contributes to the development of a standard model combining the best features of previous variations.

A patent application covering this type of skimmer has been filed by the Standard Oil Development Co., Esso Standard's research and technical affiliate. Licensing terms may be obtained from Standard Oil Development, Room 952, 15 West 51st St., New York 19, N. Y.

Meet the Author

W. O. Small, coordinator of oil conservation activities, Baltimore refinery, Esso Standard Oil Co., was born in Buffalo, N. Y. He received a B.S. from Penn State in 1934 and an M.S. in Chemical Engineering from Columbia University in 1935. In July of that year he joined Esso in the technical service division at the Bayway refinery as a junior test engineer.

In 1938, Mr. Small joined the engineering department of the Fellsmere Sugar Producing Association, subsequently becoming its chief engineer. From 1943 to 1945 he served in the U.S. Navy with the rank of Lieutenant. He returned to Esso in January, 1946, in the engineering department at Baltimore.

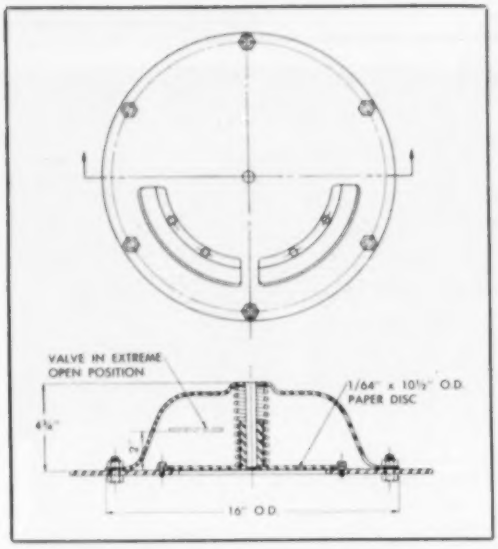


FIG. 1—Crankcase explosion-relief valve

CRANKCASE EXPLOSIONS

Their Causes and Practical Remedies

From a Report* by F. V. COOK
Master Mechanic
Service Pipe Line Co., Tulsa

CRANKCASE explosions in engines and other equipment have occurred occasionally since the first machinery was manufactured with enclosed crankcases. They have been tightly enclosed to accommodate pressure lubrication. The modern trend toward housing all auxiliary drives within the crankcase, close running fits of pistons and journals, higher operating speeds and the use of extremely thin babbitt bearings has added possibilities of overheated surfaces. The mechanical derangement of these parts provides the heat necessary for both vaporization and ignition of the lubricating oil.

It is proposed in this paper only to start a discussion of crankcase explosions by reporting the experiences of the Service Pipe Line Co. and our approach to a practical solution of the problem. This has been to provide a sufficient quantity of relief valves to relieve the pressure and thus avoid the possibility of damage to property or personnel and of resulting fires.

The literature and discussion on crankcase explosions with which the writer is familiar start with two assumptions:

1—The oil and air mixture in an engine crankcase normally is too rich to burn.

2—Piston blow-by consists primarily of the products of combustion.

It is maintained that both these assumptions are fallacious. Explosions result from ignited mixtures of vapor and air which fill the spaces between the droplets of oily mist in crankcases; piston blow-by is negligible except during the compression stroke.

These are conclusions drawn from many tests of Diesel, gas, and dual-fuel engine crankcases, made by drawing the contents of the crankcase from a shielded area to avoid including drops of lubricating oil. All natural gas engines having crankcases vented only to the atmosphere were found to contain explosive mixtures. Diesel engines contained little or no explosive vapors even when not vented.

Unvented dual-fuel engines compressing air-gas mixtures show practically no trace of combustible gas in the crankcases when burning liquid fuel. After the gas fuel is admitted, the crankcase vapors rapidly increase in gas content to approximately the same mixture being burned. By connecting the crankcase to the engine air intake and venting the opposite end, this gas-air mixture can be rapidly displaced with air.

These tests, performed many times, can lead only to the conclusion that there is sufficient blow-by on the compression stroke of every engine to place in the crankcase the same mixture being compressed by the piston. No appreciable quantities of carbon monoxide or dioxide have been found in the crankcases of Diesel or gas engines, even when piston rings were in poor condition.

In groping for an explanation, the writer remembers slow-speed engines blowing by the rings in which the sound of the leakage practically stopped at the end of the compression stroke. Another possible reason is the distance of the ring belt from the start of combustion. If the engine is burning all its fuel, excess air occupies the space adjacent to the rings because it is farthest from the start of combustion. It is hoped these statements will prompt laboratory tests by engine builders which will prove or disprove the suppositions.

The Service Pipe Line Co. experienced two serious crankcase explosions on new dual-fuel engines soon after they were placed in service during the latter part of 1948. We have experienced another, on an older engine, since the first of this year. The first and second explosions resulted from hot auxiliary drive bearings in the front end of new 7-cylinder, 1600 h.p. engines.

The first explosion, occurring while the engine was operating on liquid fuel, blew off two thin sheet steel doors and ignited the engine crankcase. Damage to the building was slight. The second occurred while operating on both liquid and gas fuel, blasted all but one door from the engine crankcase and also ignited the crankcase. Building damage was extensive.

The most recent explosion resulted from hot main and crank bearings in a six-cylinder, 500 h.p. engine that had been converted to dual fuel. This slightly damaged the building with no damage to the engine except breaking one cast iron crankcase door.

* A condensed version of a paper presented at the Petroleum Mechanical Engineering Conference of the American Society of Mechanical Engineers, New Orleans, Sept. 24-28, under the title, "Crankcase Explosions". Discussion following the presentation of the paper is given on pp. 1305 and 1306.

Both 1600 h.p. engines were vented at the front end through a 2-in. line and an Air-Maze separator to the engine air intake, but the crankcase was not open for air inlet except through leakage and via the front end lubricating oil return line to the open lubricating oil sump tank. Thus, practically all air passing through the crankcases passed the bearings, causing the explosions. Subsequent tests under identical operating conditions proved the crankcases were practically free of combustible vapors in the front end before the bearings heated and vaporized lubricating oil. However, they contained increasing amounts of combustible vapor toward the flywheel end, farthest from the vent, until the mixture stabilized at approximately the same ratio being compressed by the pistons.

The 500 h.p. engine was fitted with a similar separator and a ¾-in. vent line. The separator was plugged, so for all practical purposes the engine had no vent although the separator would not hold measurable pressure in the crankcase.

All these engines have been provided with forced ventilation by connecting the crankcase to the air intake and opening the opposite end of the crankcase to admit air. We are not certain this is the proper procedure because explosions are more frequent in Diesel than in spark-ignited gas engines, and most of the latter carry explosive mixtures in the crankcase. This may possibly be explained by assuming the mixture becomes too rich to detonate soon after mechanical derangements start adding lubricating oil vapors to the gas-air mixture. The higher temperature required to ignite methane mixtures also may be a partial explanation (petroleum vapors, approximate 1000° F; methane vapors, approximate 1500° F.).

Measures to prevent explosions which have been suggested include 1—maintaining a non-explosive mixture in the crankcase, as by passing natural gas through the crankcase to the engine intake; 2—provide means for drenching the crankcase with carbon dioxide when trouble occurs. There are obvious disadvantages to both these methods. Other suggestions have been 3—to strengthen the crankcase to withstand an explosion; 4—remove from the crankcase, insofar as possible, all sources of hot surfaces. These latter two means would not be practicable for engines now in service but should be considered for new engines.

Another solution to the problem has been to accept that crankcase explosions are possibilities and to provide the means to relieve the resulting pressure through installing the appropriate number of relief valves.

The Service Pipe Line Co. decided on the last course. We believe explosion valves for our old engines should open at low pressures to obviate expensive replacement of doors and covers. To avoid high pressures we decided to provide more relief area than the 0.5 sq. in. for each cubic foot of crankcase volume recommended by the D.E.M.A. We proceeded, accordingly, with the design of the largest valve that could be applied to the smaller crankcase doors with the idea of placing one on each door.

A general outline of the explosion relief valve selected is shown in Fig. 1. Two of these will be placed on each crankcase door of some of the large engines. Twelve hundred (1200) explosion valves will be required to equip all of our engines and several pumps. Reports of crankcase explosions breaking doors without rupturing paper blow-out diaphragms prompt placing valves on all crankcase doors.

Explosion relief valves received with new engines leaked oil when designed to open at 5 psig. and to be fully open at 15 psig., so we decided that the valve must cover a blow-out gasket serving as an oil seal. It has been possible to purchase valves as shown in Fig. 1 for $10 each and to install them economically on our flat steel doors. In some cases it was found less expensive to make new flat steel doors than to fit the valve to cast iron doors.

We have tested one of these valves by exploding natural gas in a 25 cu. ft. tank. The test apparatus is illustrated in Fig. 2. The explosion relief valve was tested by attaching it to a 3/16-in. thick by 26 in. square steel plate, and later to a ¼-in. thick aluminum plate of the same size to simulate our weakest crankcase doors.

Typical pressure indicator cards obtained while testing a 16:1 air-gas mixture show that the maximum explosive pressure of 14 psi. was reached in approximately 0.15 second and as rapidly returned to zero, after which time the ungasketed relief valve closed and held a vacuum in the tank for 80 to 90 seconds. This shows how adequately the valve relieved the explosion pressure, yet closed rapidly enough to prevent entrance of fresh air, which could sustain a secondary explosion.

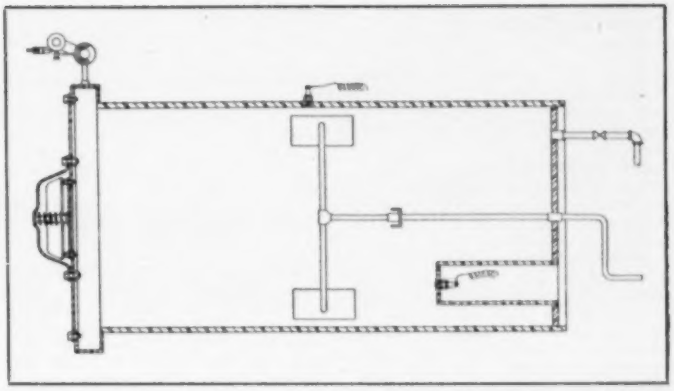


FIG. 2—Test Tank with relief door, used for testing relief valve action via indicator card

During other tests we were able, by varying the mixture and agitation, to obtain maximum pressures of 20 psi. With the relief valve removed and an 0.01563 in. thick by 10.5 in. diameter paper gasket used to seal the tank, the maximum pressures decreased about 20% but the safety feature of the reseating valve was lost.

A final test was made with a solid steel plate in place of the paper gasket. Under this condition the maximum pressure was 80 psi. which was relieved by leakage at the door gasket. The center of the quarter-inch thick aluminum door bulged outward about 5 in. and took a permanent set of about 2 in. Had the door been made of cast iron it doubtless would have shattered.

* * *

An informative discussion followed the presentation of Mr. Cook's paper, which reveals the existing difference of opinion as to the causes of explosions in engine crankcases. The discussion, in condensed form, is given below.

* * *

S. C. Phelps, Interstate Oil Pipe Line Co., said he believed the majority of explosions occur in engines employing a dry crankcase with an external lube oil sump because the wetting and cooling effect of the oil supply held in a wet crankcase engine is lost. Consequently, when a mechanical failure occurs, heat dissipation is slower than in the wet crankcase engine. The majority of large Diesels have dry crankcases. He advocated use of floating-pin pistons as a modern trend decreasing pos-

sibilities of overheated surfaces, commenting that elimination of distorted pistons resulting from driving piston pins, by substitution of floating-pin design, has greatly reduced scoring of pistons and liners. Improvements in materials used and piston pin bearing design likewise has reduced the possibility of ignition from piston pin failures.

Scouting opinions of some operators that blow-by is a cause of ignition, he commented that, for this to be true, the engine would have to be in a mechanical condition incompatible with modern maintenance and operation standards. The most conceivable and definitely determined ignition source is mechanical failure of some engine part and, so long as rotating and rubbing parts are enclosed in the crankcase, this source cannot be eliminated. It can be reduced by improved maintenance schedules, more skilled maintenance and operating personnel, and better and more frequent inspections.

Ventilation of the crankcase is the most practical means of preventing explosions. The system used must prevent eddy pockets in remote crankcase locations and be designed for each model engine so that the air stream will pass over as many bearings and moving parts as conditions permit. Even then the possibility of an explosion will exist and the relief valve seems the best answer to date, he stated.

* * *

Edgar J. Kates, Consulting Engineer, New York, believed Mr. Cook was unduly pessimistic about avoiding crankcase explosions and said his limited faith in forced ventilation is possibly due to his erroneous opinion that the combustible part of the explosive mixture *always* is gas or vaporized oil and never the suspended droplets of lubricating oil. He brought out that the experiments with Diesel engines were inconclusive because he drew off the crankcase atmosphere from a shielded area, deliberately avoiding inclusion of lubricating oil drops.

He pointed out that the normal contents of an unventilated Diesel crankcase are explosive, and that, in addition, engines which compress gaseous mixtures may have explosive crankcase atmospheres due to blow-by during the compression stroke.

If Mr. Cook's two sources of explosive mixtures were the only causes, said Mr. Kates, straight Diesel engines never would explode unless a substantial amount of such local overheating had occurred to vaporize the neighboring oil. The fact is Diesel explosions have occurred with nothing more than sparks as the ignition cause. This indicates an overheated bearing usually causes an explosion because it acts as the ignitor of a previously existing combustible mixture and not because it vaporizes some oil.

Mr. Kates is convinced forced ventilation is the best practical preventative of explosions. If thorough, such ventilation would purge cases of gas-air mixtures and also the combustible oil droplets in suspension in *all* engines, including Diesels.

* * *

J. D. Jones, Gulf Refining Co., Tulsa Refining Division, in commenting on Mr. Cook's assumption regarding the action of piston rings, said that, if correct, this should provoke thinking on part of piston ring manufacturers in the direction of providing rings more readily conforming to cylinder liner contours, irrespective of cylinder pressure or liner condition.

He suggested mechanical derangements of moving parts may be solved by revising inspection schedules and maintenance routines, commenting that explosions in locomotive-type Diesels had not been reported, to his knowledge, and the completely different method of operation might lend itself to newer and better designs or maintenance methods.

He also asked if the presence of the torn gasket after the explosion in any way impaired seating of the explosion-relief valve design described. Mr. Cook replied there was no evidence of interference with valve seating from the torn gasket, as the indicator cards showed the trapping of a vacuum. Although there is some return of air immediately following the explosion, not enough is admitted by the closing valve to cause a fire.

The valve will be so arranged that any flame will be directed downward. Although located in what is believed the safest place, were an operator under the valve he might be burned when it opens.

* * *

R. L. Boyer, Copper-Bessemer Corp., agreed with Mr. Cook's conclusions that closed cases are responsible for explosions and fully agreed with all cited ignition sources except thin babbitt bearings. His company's experience definitely showed they aid in helping eliminate explosions since bearing failures are much less frequent, he said, adding that Mr. Cook's contrary experience may have resulted from attempts to make thin-wall babbitt bearings without full access to present methods of bonding.

An extensive investigation of known cases of explosions, largely of marine engines, has been made by the American Bureau of Shipping and these cases have been discussed with representatives of the Diesel Engine Manufacturers Assn., it was brought out. Practically all reported explosions involved engines having some form of forced ventilation. If it were possible to use a large quantity of air to ventilate the crankcase, very lean, non-explosive mixtures should result.

However, there are two possible pitfalls, it was stated: The quantity of air circulated would have to be quite large and this, in turn, would immediately result in excessive oil consumption, tempting the operator to reduce it. A possible third is involved in the fact that the common hot spots on moving parts generally are located in pockets not readily reached by forced ventilation. Consequently ventilating the crankcase merely supplies oxygen to perpetuate explosion or fire.

Mr. Boyer agreed that every engine should be protected by explosion relief valves, which should be quick-seating to prevent an inrush of air and used with a thin gasket to prevent oil leakage. Mr. Cook's design was questioned on the grounds that it might not be sufficiently quick-acting. The valve used by Cooper-Bessemer, it was explained, consists of a number of feather-weight strips of steel, very quick-acting and quick-seating; a thin blow-out gasket is used and the valve openings are pointed downward.

* * *

George Stevens, Worthington Pump & Machinery Co., commented that crankcase explosions are not confined to internal combustion engines, although their higher operating temperatures may contribute to the possibility, in comparison to other mechanical equipment. He also pointed out that obtaining a homogeneous atmosphere through ventilation would be difficult in pocketed areas. The probable reason for more explosions being experienced with Diesels than spark-ignited engines is possibly the same reason the farmer had more trouble with white than black cows—he had more white cows.

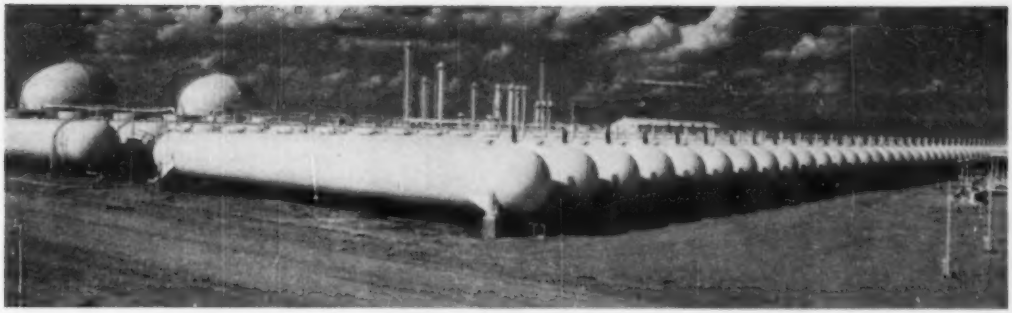
He commented further that:

1—It would be extremely difficult to strengthen medium and large-sized engine crankcases to withstand explosive forces.

2—Tin-plated pistons might prove of some value initially, but the plating wears off soon and the cast-iron piston is exposed to the liner.

3—The D.E.M.A. has concluded that the best procedure is to minimize the effect of explosions rather than the more difficult route of eliminating the causes.

4—Worthington has found that rectangular plates, properly guided and supported by springs, are effective because they provide a greater relief area than a circular plate and can be conveniently and simply produced. They are located in sufficient quantity along the entire crankcase length so that, regardless of where the explosion originates, adequate protection will be furnished.



LPG STORAGE TANKS at Plymouth Oil Co.'s new gas processing plant in the Benedum field have a total capacity of nearly 87,000 bbls. of butane and propane

Gasoline Plant's Storage Holds Over 140 Days' LPG Production

THE world's largest reported propane-butane storage installation is located at the Plymouth Oil Co.'s new gasoline plant in the Benedum field in Upton county, Texas. Its capacity, 6 644,674 gals., is sufficient to store over 140 days' production of the plant, thus enabling the company to hold its supplies for economically favorable markets. The storage serves both tank car and truck loading racks.

The storage tank battery installed at the Plymouth's Rankin plant consists of 56 tanks for propane, of total capacity of 3,652,194 gals., and 30 butane tanks, of 1,992,480 gals. capacity. The average daily output of propane at the plant is 17,000 gals. of normal butane, 7000 gals. of isobutane, and 13,000 gals. of propane. These figures are based on the current volume of gas being handled, 37,000,000 cu. ft. per day.

The 56 propane tanks are 10 ft.-6 in. in diameter and 108 ft. in length. Capacity of each tank is 65,940 gals. and they are built to stand 225 lbs. pressure, the propane being held at approximately 215 lbs.

The Rankin storage includes 30 butane tanks, 12 ft. in diameter by 70 ft.-6 in. S to S. The capacity of each tank is 66,402 gals., the butane being held at approximately 100 lbs. pressure.

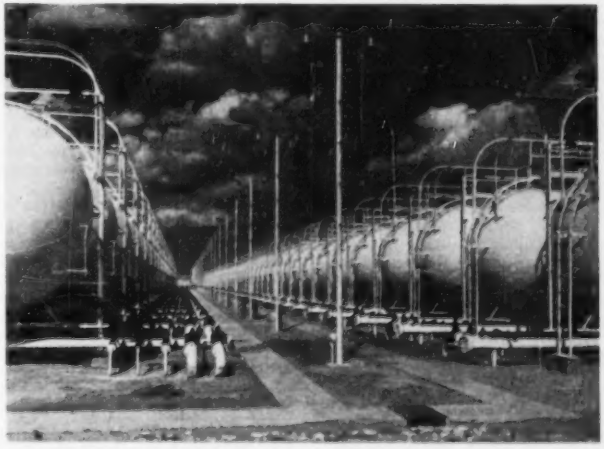
Both the butane and propane tanks are supported by two cradles, with the rear cradle resting on rollers so the tank can expand or contract lengthwise. This type of cradle is said to be in common use for propane-butane storage. The top of the concrete foundation to which the cradles are bolted is 2 ft. above the ground. The loading pumps are of the vertical type and were set below the ground inside a piece of 14-in. pipe, with the suction and discharge connections just above the ground. The pressure held on the loading and unloading lines is the same as the tank pressure of the product being stored.

In order to prevent the loss of products during the loading of trucks or tank cars, there is a 2-in. return line from the trucks or cars back to the tanks. Since all of the loading operation is done at the normal pressure of the product being handled, it is not necessary to provide for handling vapors.

The only treatment given either the propane or butane prior to transferring the product to storage is to run the propane through driers to remove any water present. This is done not for the reason that the product may be held in storage for a long time, but because it is necessary to make the product marketable.

The Plymouth Oil Co.'s Rankin plant is an absorption type, its total capacity being considerably in excess of the 37,000,000 cu. ft. of gas currently handled.

The propane tanks were fabricated by the McNamar Boiler and Tank Co., Tulsa. The butane tanks were built by the Wyatt Metal and Boiler Works, Houston. The valves and fittings are of the conventional type, the valves being supplied by the Nordstrom Valve Division of Rockwell Manufacturing Co. and the Walworth company. The relief valves were made by Manning, Maxwell & Moore, Inc. The loading pumps are Byron Jackson VMT type.



THIS MONTH'S COVER PICTURE—Closeup view of the front ends of the 86 butane-propane storage tanks at Plymouth's new gas processing plant. The 30 butane tanks are on the left, the 56 propane tanks on the right

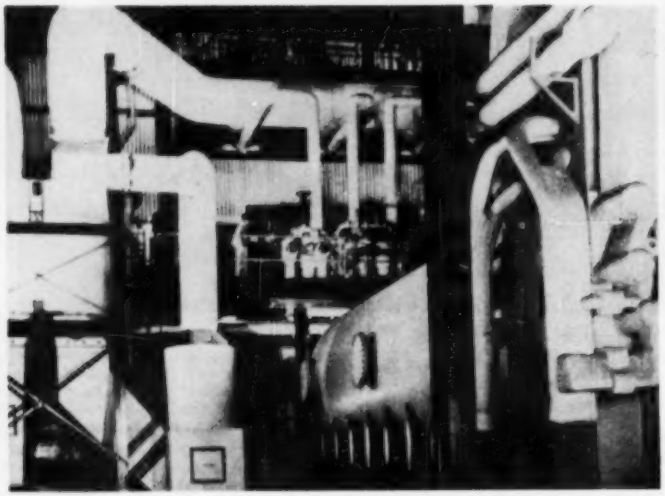


Photo courtesy Lion Oil Co.

PETROCHEMICAL OPERATIONS such as this ammonia synthesis plant of Lion Oil Co. at El Dorado, Ark., have heightened interest in processes for producing . . .

Water Gas from Methane

By PETER W. SHERWOOD
The Koppers Co.

THE growth of the petrochemical and oil synthetics industries during the post-war years has brought with it important expansion and development in processes involving the conversion of methane to water gas. In many locations where methane is available at low cost, these processes offer a satisfactory means of producing synthesis gases and hydrogen at costs considerably below those achieved by the gasification of coke, which is the principal source of America's water gas production today.

By definition, water gas is a mixture of carbon monoxide and hydrogen, produced in various degrees of purity. Principal chemical uses for the gas include the manufacture of methanol, ammonia, synthetic liquid fuels, OXO alcohols, and various hydrogenated products ranging from cyclohexane to vegetable shortening and to a number of petroleum specialties.

The importance of water gas to many of these processes depends on the readiness with which it can be converted to hydrogen of high purity. This conversion merely involves the reaction of carbon monoxide with steam under controlled conditions[1] for the formation of hydrogen and carbon dioxide which can be readily separated.

$$CO + H_2O = CO_2 + H_2 \qquad (1)$$

Other processes (notably methanol synthesis and the Fischer-Tropsch process) call for the use of a water gas containing carbon monoxide and hydrogen in a strictly controlled ratio.

Outline of Available Processes

By thermal cracking of methane it becomes possible to obtain a fairly pure grade of hydrogen:

$$CH_4 \rightarrow C + 2H_2 \qquad (2)$$

The necessity to free the product completely of entrained carbon dust, in order to make it chemically useful, often adds an unbearable economic burden to the process. It can be seen, moreover, that one volume methane will yield a theoretical maximum of two volumes hydrogen in the thermal cracking process. This is only one-half of the hydrogen or water gas production theoretically possible from the same amount of methane by the reforming processes to be described in this paper.

In actual practice, Reaction (2) serves only where the primary purpose of the plant is the production of lamp black. Pure thermal cracking processes of this kind accounted for the manufacture of some 85 million lbs. carbon black in 1945 (approximately 7% of the total American output). Hydrogen formed as byproduct in this operation would have sufficed for the manufacture of 75,000 tons ammonia, or only about 5.5% of the entire national production.

Economically, a sounder process for the production of water gas (or hydrogen—cf. Equation (1)) involves the action of steam on methane to form a mixture of carbon monoxide and hydrogen. In its earlier forms, due to Etablissments Kuhlmann and Koppers G.m.b.H., the conversion was carried out thermally at temperatures above 1800° F. Catalytic processes, developed by Standard Oil Co. of New Jersey and I. G. Farbenindustrie A. G. made their appearance in the late '30s. The catalytic process has the advantage of permitting operations at lower temperatures and consequent better heat economy but requires extensive pre-purification of the raw gas.

The reaction of steam (or carbon dioxide) with methane is highly endothermic. Costly tubular or regenerative furnaces are required and considerable amounts of capital are tied up in heat exchangers. During recent years considerable interest has been shown in thermally self-sustaining methane re-forming processes. This approach involves the simultaneous action of steam and oxygen on methane, again to form carbon monoxide and hydrogen (together with the unavoidable by-products, notably carbon dioxide). This process has distinct economic limitations. Generally it calls for the erection of a costly oxygen plant, which is feasible only in plants using water gas on a very large scale (e.g. in the gas synthesis plant now being erected at Brownsville, Texas).

In plants where water gas serves as the raw material for ammonia synthesis, the presence of nitrogen is not objectionable, and air can be used instead of pure oxygen to assist in the production of synthesis gas. However, here too, the product gas will have an unduly high nitrogen content and enrichment with pure hydrogen is required in order to achieve the required 3:1 hydrogen-to-nitrogen ratio. Such a plant would, therefore, require two reforming units, one involving the pure steam-methane process and another in which methane is reformed by the simultaneous action of air and steam.

Another approach to the problem of ammonia synthesis gas production from methane is practiced at the El Dorado plant of Lion Oil Co.[2]. Here, methane is reformed catalytically by the action of steam in amounts insufficient to achieve full conversion. The residual methane is converted by the action of air in the presence of a nickel catalyst. The resulting mixture of nitrogen, hydrogen, carbon monoxide, and carbon dioxide can be readily transformed to the desired mixture of nitrogen and hydrogen by the water gas shift reaction followed by CO_2 and CO-scrubbing[1].

Alternate approaches involving the use of nitrogen from flue gases or from low-temperature air separation plants have found favor at various plants.

Steam Re-Forming of Methane

At the present time, the steam-hydrocarbon reaction is still used uni-

versally in the U. S. for the industrial production of water gas from methane. From an academic point of view, the system is highly complex, involving the formation of CO, CO_2, H_2, C, O_2, C_2H_6, C_2H_4, etc. In actual practice, however, the only products formed in significant amounts are carbon monoxide, carbon dioxide, and hydrogen. By the elimination of mutually interdependent reactions which are capable of taking place, the system can be reduced to two major equations:

$$CH_4 + H_2O = CO + 3\,H_2 \quad (3)$$

$$CO + H_2O = CO_2 + H_2 \quad (1)$$

In addition, there is a very definite possibility of carbon formation according to the equation:

$$2\,CO) = CO_2 + C \quad (4)$$

or: $$CH_4 = C + 2\,H_2 \quad (5)$$

Because of its tendency to obstruct the catalyst and passages of the reforming furnace, it is necessary to avoid or at least minimize carbon formation by the use of adequate quantities of steam. It is this criterion which determines the minimum quantity of steam (or carbon dioxide) which still permits smooth operation of the methane re-forming process.

An evaluation of the relationships in an operable steam-methane system shows that the reaction permits 3 degrees of freedom. Thus, any 3 variables may be fixed from a list including: temperature, pressure, methane content of products, CO/H_2 ratio in make gas, steam rate, etc.

The choice of temperature depends largely on whether the process is to be executed thermally or catalytically. At the same time it must be coordinated with the steam rate in order to establish the desired end results with the greatest degree of economy. A high temperature permits a lower steam rate for the same degree of methane reduction but introduces additional costs due to greater fuel gas consumption and more severe service conditions. The effect of temperature on methane conversion (at theoretical steam rates) is strikingly illustrated by Fig. 1.

The relationship between the equilibrium positions of Equations (1) and (3) is such that—in the presence of the theoretical quantity of steam—only very little carbon dioxide is formed at temperatures above 1850° F., while the amount of carbon monoxide present in the products is negligible if the reaction is carried out below 1050° F.

A look at Equations (3) or (7) shows that pressure has a very pronounced effect on the position of the equilibrium. For any given temperature and water rate, the residual methane at equilibrium is a direct function of the square of the pressure. In general, the conversion is carried out at atmospheric pressure.

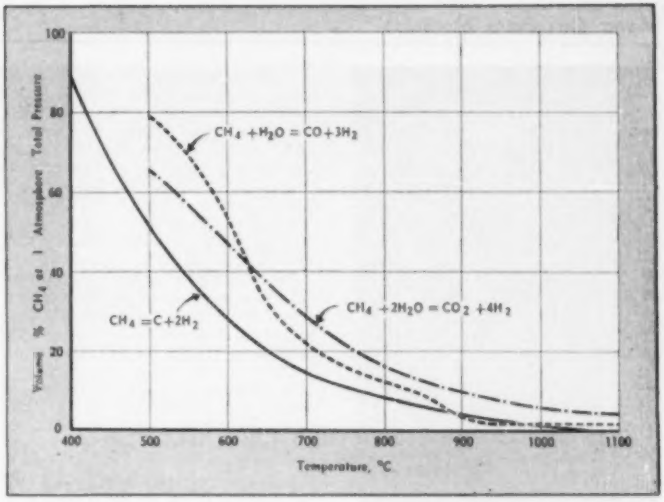


FIG 1—Effect of temperature on steam-methane reforming

However, instances are known in which pressure operation was found to be more economical. Such a situation existed at the ammonia plant of the Missouri Ordnance Works (now The Bureau of Mines Coal-to-Oil demonstration plant at Louisiana, Mo.) where natural gas was received at 450 psi.[3] Since the re-formed gas was also required at elevated pressure for the purposes of the ammonia synthesis, it was found to be cheaper to carry out the entire conversion at "as received" pressure, thereby effecting very considerable savings in the cost of compression.

For thermal reasons—and often to satisfy the requirements of the synthesis catalysts—it is desirable to achieve maximum reduction of methane content. In normal practice, the very high steam rates required to reduce the last remnants of methane are found to be uneconomical. Large-scale users of the process—notably methanol, high-pressure hydrogenation, and gas synthesis plants—generally consider a metnane content of 1-2% in the make gas to be satisfactory. In special cases, a higher degree of freedom from methane may be required and a hydrogen make containing as little as 0.1% methane has been reported[4].

The required carbon monoxide/hydrogen ratio is determined by the desired end use of the water gas. Thus, the gas synthesis (Fischer-Tropsch) process calls for a ratio varying between 1:1 and 1:2 depending mainly on the catalyst, while methanol synthesis requires a ratio of 1:2. The steam-methane process yields a gas too rich in hydrogen for these purposes and adjustment must be made either by admixing carbon dioxide to the reaction steam, or by procuring carbon monoxide-rich gas from some other source.

The undesired presence of carbon monoxide in the make gas of plants where methane re-forming serves as a source for hydrogen is dealt with by subjecting the crude product to water gas conversion (cf. Equation 1) in a separate step operated at approximately 750° F.

Equilibrium constants for all reactions involved in methane re-forming have been determined experimentally. A good summary of their values has been tabulated by Reitmeier and co-workers[5]. The knowledge of these constants permits accurate calculation of equilibrium conditions. The methods employed are straightforward, although somewhat time-consuming. For different approaches to this problem, the reader is referred to the publications of Dodge[6], Reitmeyer[5], and Mayland[7].

Industrial Use of Steam-Methane Reaction

The steam-methane reaction is carried out thermally at temperatures in excess of 2250° F. The very high temperature level is set by reaction-kinetic rather than by equilibrium considerations. Brickwork regenerators of the type employed in conjunction with blast furnaces are the normal operating equipment. Operation is cyclical. Steam and raw gas enter via preheaters into the furnace, which has been preheated to reaction temperature by gas combustion. The re-formed make gas is withdrawn via another preheater to which it imparts most of its sensible heat. Some carbon black is formed as by-product and must be removed from the effluent gas stream by water scrubbing.

This process has been practiced in Europe (e.g. at Linz, Austria, and Oer-Erkenschwick, Germany) for the manufacture of hydrogen from coke-oven gas. Today, it is mainly of his-

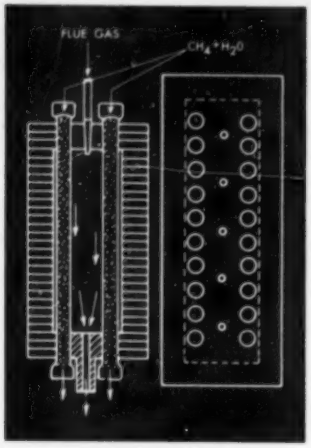


FIG. 2—Converter for catalytic steam reforming of methane

torical interest and has been almost universally superseded by American catalytic re-forming practice.

The primary reactions involved in re-forming methane are strictly reversible. Catalysts which prove useful for their acceleration are accordingly of the methanation type. Fischer and Tropsch[5] have made a classical study of catalysts useful for methane re-forming and found that nickel and cobalt are the most satisfactory, especially when employed on a clay or alumina support. Iron, copper, molybdenum, and tungsten were shown to be poor catalysts at the reaction conditions studied (860-1000° C.).

Not all catalysts which are useful for methane re-forming are equally active in the promotion of water gas conversion. Within the short contact time normally allowed, a considerable portion of methane may be converted according to the equation:

$$CH_4 + 2\ H_2O = CO_2 + 4\ H_2 \quad (6)$$

If the catalyst is not particularly active in the water gas conversion, insufficient time may be available for the equilibration of product carbon dioxide to carbon monoxide and steam. Under such circumstances the product composition may be found to be very much richer in carbon dioxide than expected from equilibrium calculations. This possibility has been strikingly demonstrated by Matignon and Séon[9], who re-formed methane with steam at 1050° C. in the presence of thoria and zirconia catalysts and obtained a make gas of high carbon dioxide content.

In industrial practice, nickel-base catalysts are almost universally employed. The catalyst is usually supported on alumina or magnesite and may be promoted by the addition of copper.

The re-forming reaction proper is carried out catalytically at temperatures ranging between 1300 and 1700° F. Normal-pressure operation generally does not exceed 1500° F. while higher temperatures may be required for conversion at elevated pressures.

Fig. 2 shows a typical furnace employed in the catalytic reforming of methane by means of steam. The catalyst is arranged in high-temperature alloy steel tubes which are exposed to external gas heat. The diameter of the catalyst tubes is limited by heat transfer considerations, since it is undesirable to exceed wall temperatures of 1800° F.

Operation at Billingham[10] is carried out in a furnace carrying 66 standard 6-in. tubes while the Louisiana, Mo. plant[3] employs catalyst tubes 8 in. in diameter x 40 feet long, 4 tubes per bank, and 8 banks per furnace.

Operating data for catalytic steam-methane reforming at Billingham have been reported by Gordon[10]. The data, which are shown in Table 1, are typical for the process developed by Standard Oil Co. of New Jersey and check closely the industrial performance of the I. G. Farbenindustrie process practiced at Wesseling[11].

Partial Oxidation Processes

The principal engineering problem in the steam-methane water gas process is bound up with the very high endothermic heat of reaction which must be supplied from external sources. An attractive alternate method is to subject a portion of the feed methane to one of the exothermic combustion reactions by the admixture of oxygen to the steam-methane system. The combustion may proceed according to two fundamental reactions:

$$2\ CH_4 + O_2 = 2\ CO + 4\ H_2 + 18\ \text{kcal.} \quad (7)$$

$$CH_4 + 2\ O_2 = CO_2 + 2\ H_2O + 214\ \text{kcal.} \quad (8)$$

At reaction temperatures normally encountered, the equilibrium constant for Reaction (8) is very much larger than for Reaction (7). Consequently, the natural tendency of the system is to form predominantly carbon dioxide and steam. This progress of the reaction is, however, immediately influenced by the simultaneous occurrence of the steam-methane reactions and by the water gas shift reaction, which eventually establish an equilibrium gas composition rich in carbon monoxide and hydrogen if the system is given sufficient contact time, and if, preferably, methane reforming catalysts of the type described above are employed.

A particular advantage of pure partial combustion processes is the fact that carbon monoxide and hydrogen are formed essentially in the ratio 1:2 and the make gas is thus immediately usable for methanol synthesis and for certain versions of the Fischer-Tropsch process. This approach is, however, strongly influenced by the relatively high cost of oxygen and, in most cases, it is found to be more economical to carry out the conversion of methane by the simultaneous action of oxygen (exothermic reaction), carbon dioxide and steam (endothermic reaction) in proportions controlled for the achievement of thermal balance.

One of the earliest operative systems for the partial combustion of

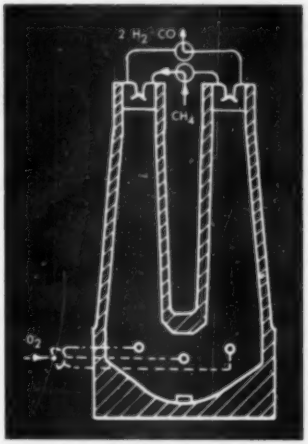


FIG. 3—Linde-Karwat converter for oxygen reforming of methane

TABLE 1—Operating Conditions for Steam-Methane Reforming Plant

Gas	Rate Cu. Ft./Hr.	Analysis (Per Cent) H_2	CO_2	CO	N_2	HC's	O_2	H_2O
Hydrocarbon gas	111,000	46.0	...	...	4.8	48.2	...	...
Reformed gas	613,000	74.8	11.3	11.8	1.0	1.3	...	...
Catalyzed gas	656,000	77.1	17.7	3.1	1.0	1.1	...	...
Flue gas	784,000	...	12.5	...	66.8	...	4.6	16.1
"H" water gas—Fuel	205,000	52.5	6.3	38.7	1.5	0.4	0.2	...

Material	Usage or Make
HP steam	11.1 tons/hr.
LP steam	5.5 tons/hr.
Hydrocarbon gas	111,000 cu. ft./hr.
Reformed gas + steam	870,000 cu. ft./hr.
Reformed gas	613,000 cu. ft./hr.
Catalyzed gas	656,000 cu. ft./hr.
Flue gas	784,000 cu. ft./hr.

Overall thermal efficiency (including water gas conversion) = 73.8%

methane is due to Linde-Karwat (see Fig. 3). The two legs of the converter are filled with coke. Methane is introduced through one of the two legs, picking up stored heat until it reaches the bottom portion of the unit, where it is joined by a stream of oxygen and steam in suitable proportion to carry out the partial combustion and conversion at 2450° F. The effluent gases give up their sensible heat to the coke in the exit leg of the furnace. The direction of gas flow is alternated periodically. A small portion of coke is burned in the process. However, most of the gas production and heat supply is due to the conversion of methane.

A more modern approach to the partial combustion of methane involves two-stage operation. Methane is first burned by means of oxygen (or an oxygen-methane mixture), mainly in accordance with Equation (8). The heat developed in the course of combustion is absorbed by the endothermic equilibration reactions (formation of carbon monoxide and hydrogen from methane, carbon dioxide and steam) which are guided catalytically in a second stage. The process is completely autothermic.

To protect the nickel catalyst from poisoning, a high degree of freedom from sulfur is desirable in this process. The poisoning effect is, however, not serious at very high temperatures and the presence of sulfur may be permitted at the cost of lower thermal efficiency and higher oxygen consumption.

Typical of this partial oxidation approach to the reforming of methane is the Oppau KW process of I. G. Farbenindustrie[11, 12], which is illustrated in Fig. 4. Moisture-saturated methane and oxygen (or air, if nitrogen is not objectionable in the product) are preheated separately to about 1100° F. and are introduced into the upper portion of the converter furnace where primary combustion takes place. The gases pass from here to the secondary reaction zone in which equilibration takes place in the presence of nickel catalyst—with the addition of steam and carbon dioxide if so desired. Upon leaving the reactor, the requisite amount of product gas passes through the tube-and-shell feed gas preheaters. The entire make gas is cooled in a water tower and is then freed of entrained soot by filtration or water scrubbing.

The incoming gases in the mixing zone have a composition within the explosive limit and must be protected from back-firing from the combustion space. The two zones are therefore separated by a bank of tubes of small diameter through which the gases pass at a velocity exceeding the critical extinction velocity of the system.

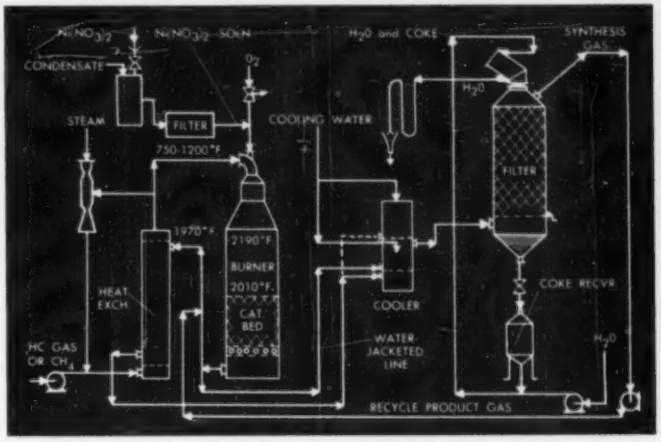


FIG. 4—Flow sheet for the reduction of water gas by the partial oxidation of methane

The presence of carbon monoxide in the system at high temperatures results in the gradual deterioration of the nickel catalyst in the equilibration section due to the formation of volatile nickel carbonyl. This problem can be overcome quite simply, however, by the introduction of an aqueous nickel nitrate solution into the upper portion of the furnace to serve as a make-up source for nickel losses.

A typical gas obtained from the conversion of methane by the Oppau process has the following composition.

Component	%
CO_2	7.0
CO	23.8
H_2	69.0
CH_4	0.2

Oxygen consumption is approximately 45 lbs./M cu. ft. methane converted. Steam consumption is 6-10 lbs./ M cu. ft. methane. 3.2 cu. ft. make gas is obtained per cubic foot methane converted.

The production of synthesis gas by the partial combustion of methane under pressure is thermodynamically sound. Methane content can be reduced below 1% and carbon formation can be essentially avoided. Engineering problems are, however, very severe and a proper reactor design has not so far become known.

Some pilot-plant data have become available on the Schmalfeldt process[13] for the pressure reforming of methane by means of oxygen. The process is operated in purely thermal fashion. Oxygen consumption is stated to be 550-650 cu. ft./M cu. ft. methane. The make gas contained as little as 1.2% methane but was rich in carbon dioxide (23.6%). On the whole, operation of this process has not met with success. Development along these lines holds, however, promising potentialities for the petrochemical and synthetic oil industries.

Partial combustion processes permit a wide range in the composition of the product. By judicious selection of reactants it is possible to produce directly a feed gas for Fischer-Tropsch or methanol synthesis which requires merely the removal of carbon dioxide before admission to the synthesis plant. By reacting the methane with air, oxygen and steam in proper proportions, this approach allows the direct manufacture of raw gas for nitrogen fixation containing the required $N_2/(CO + H_2)$ ratio of 1:3. Carbon monoxide in the product can, of course, be readily converted to an equal volume of hydrogen by the water gas shift reaction.

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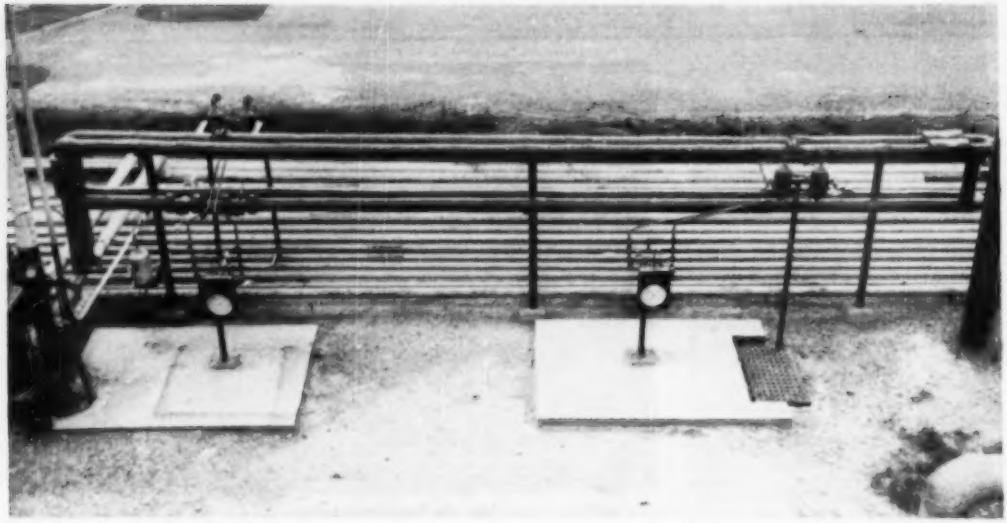

FIG. 1—A DUAL ORIFICE METER installation, one of four, in a government synthetic rubber plant at Baton Rouge, La.

How Dual Installations Checked The Accuracy of Orifice Meters

A description of 4 carefully installed and maintained dual orifice meters is presented, along with the results of a study of their precision and accuracy in measuring liquid C_4 hydrocarbon streams. Examination of 2544 sets of meter charts from the dual meters, taken over a period of 4 years, indicated that the two meters agreed within 1% for 85% of the time. Comparison of the quantity indicated by such meters with that indicated by gauges on water-calibrated receiving drums showed an agreement of 99% for over 60% of the time, and an average agreement of 99.3% over approximately 2 years.

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THE operation of plants for the government's synthetic rubber program at Baton Rouge, La., during World War II required that accurate measurements of certain light hydrocarbon streams between these plants and nearby private concerns be provided for accounting purposes. Two identical orifice meters were installed on each of the streams in order to provide normally a double check on the flow quantities and to insure continuous records during the time one meter was down for routine maintenance or overhauling. It was stipulated in the operating contract with the government that the average reading of the two meters would be used for accounting figures and that the deviation between them should not exceed 3%.

The dual meter installations possessed some features not ordinarily found in commercial installations, designed to reduce the metering errors to a minimum. These installations were carefully maintained on a regular schedule and received additional maintenance when it was indicated to be necessary. In addition, the recorder chart from each of the meters was integrated by two persons to serve as a check and thereby minimize the error in this operation.

Because of the lack of published data, a study was made of certain of the dual meter installations to determine the degree of precision and accuracy which can be expected of carefully installed and well maintained commercial orifice meter installations. Four of the dual meter installations which were located on relatively non-fouling and pulsation-free streams were chosen for this study. It was possible to examine the accuracy of one of the 4 installations, since the stream on which it was located was also measured in calibrated drums. It is the purpose of this paper to describe the meter installations and give the results of this study.

Description of Installations

The specifications for the installation of the dual orifice meters included all the principles and details generally recognized as sound orifice meter practice for the measurement of liquid hydrocarbons. Some features, in addition to those ordinarily found in commercial orifice meters, were included in an attempt to obtain an installation in which the errors were reduced to a minimum such as longer than usual metering runs, special precautions to prevent vaporization of the hydrocarbon, and facilities to remove entrained immiscible liquids, gas, or solids from the stream. By following these speci-

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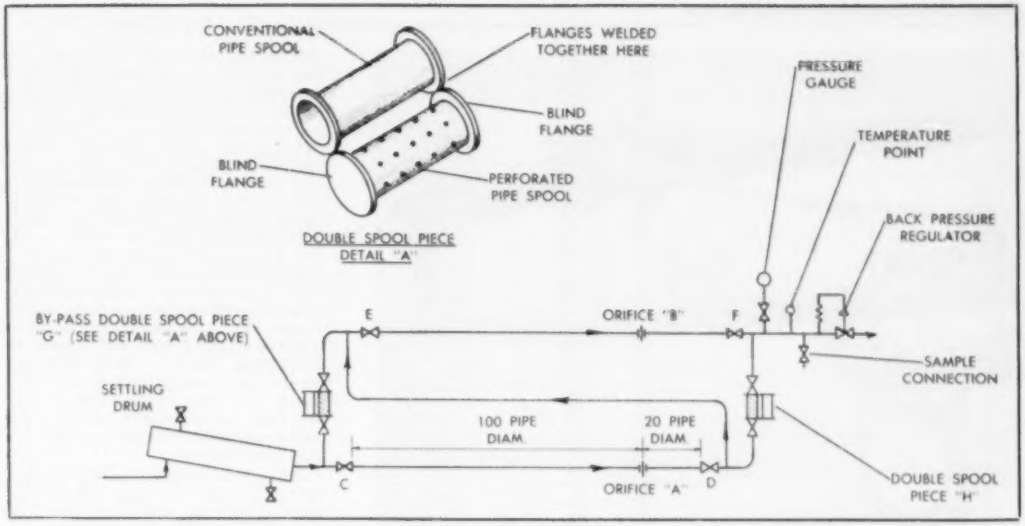


FIG. 2—TYPICAL ARRANGEMENT of a dual orifice meter installation is shown in this diagrammatic sketch

fications it was believed that the metering errors would not exceed 1%. The responsibility for seeing that the specifications were rigidly adhered to and that the meters were properly maintained at all times was assigned to one man who was familiar with good metering practices.

An actual dual orifice meter installation with the housing omitted is shown in Fig. 1, and a sketch of a typical installation is shown in Fig. 2. The stream being metered first passed through a settling drum which served to remove entrained immiscible liquids, gases, and solids. The stream then flowed through a straight section of pipe containing an orifice and thence through a second straight section to a second orifice identical with the first. By-pass connections permitted either orifice and its metering run to be removed for inspection, or changed while the metering installation was in operation. Downstream of the second orifice provisions were made for obtaining the pressure, temperature, and samples of the stream. Both orifices were equipped with identical seal pots and recording meters. The orifices, seal pots, and recording meters of the 4 installations under consideration were enclosed in a protective house. Details of the installations are given in the following paragraphs.

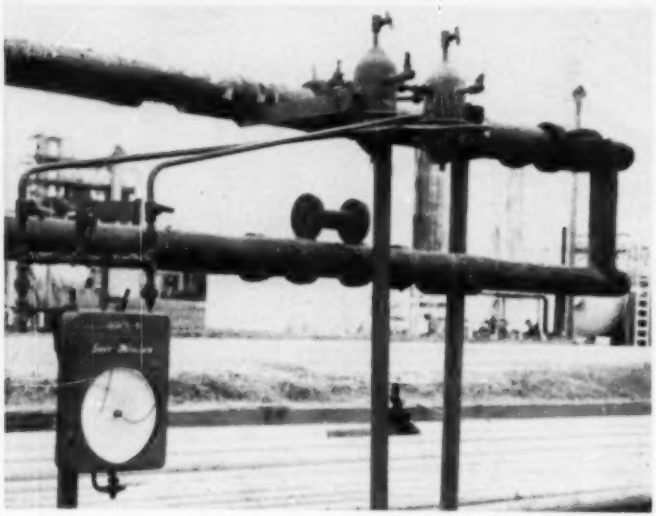
Since relatively light liquid hydrocarbons were being handled, the importance of facilities to prevent their flashing was recognized. Where the hydrocarbon was in equilibrium with its vapor, a pump to increase the pressure or a cooler to decrease the temperature was provided ahead of the metering installation. In those cases where a stream flowed into a region of low pressure (even though a pump or cooler had been provided) and there was the possibility of flashing, a back pressure regulator was installed downstream of the metering facilities to maintain sufficient pressure on the stream to prevent flashing.

A settling drum was provided upstream of each dual metering installation to separate any entrained gas and water or solid particles which might lodge behind the orifice plate or plug it, even though all the ordinary precautions had been taken previously to prevent these materials from entering the streams. The settling drums were fabricated of 8 or 12-in. pipe with a length of 6 ft., or longer if necessary to give a minimum settling time of 30 secs. The drums were installed with a slope of 1 in. in 6 ft. A perforated baffle plate was installed near the inlet of each drum to insure good flow distribution and, consequently, good settling conditions for entrained materials. Connections were installed at the high and low points in the drum downstream of the baffle for withdrawing trapped gas and water, respectively. During operation the gas and water withdrawal valves were checked as frequently as was found necessary to prevent the passage of water or gas through the drum. A by-pass line with a block valve was installed around the drum so that operation could be continued in the event the flow-distribution baffle became plugged.

For the main line containing the orifice plate, a minimum size of 2-in. standard pipe was specified, and where a choice of pipe size was possible, it was specified that a larger diameter pipe be used. A distance of at least 100 pipe diam. was provided upstream between the orifice plate and the nearest fitting or connection, as compared to the usual commercial specification of 50 diam.

Meet the Author

L. V. Cunningham, Jr., mechanical engineer, Esso Standard Oil Co., Louisiana Division, Baton Rouge, was born in Celina, Texas, February 28, 1921, and has been a member of Esso since July, 1943. He was graduated from Louisiana Polytechnic Institute at Ruston following public school education in Shreveport, La. He received a B. S. in Mechanical Engineering from LPI in 1941 and then spent two years working toward requirements for a Master's at Illinois Institute of Technology, at which point he joined Esso. He completed his M. S. in Mechanical Engineering at Illinois Tech in June, 1947. Today, Mr. Cunningham is a member of the Mechanical Technical Service Group of the Mechanical Engineering Dept. at Esso's Baton Rouge plant. He is a member of the ASME.



CLOSE-UP VIEW of one-half of a dual orifice meter installation at the Baton Rouge plant

where maximum accuracy is sought. Similarly a straight line section of at least 20 pipe diam. was installed downstream of the orifice plate, as compared with the 10 diam. usually specified.

The inside of the piping chosen for the orifice runs was cleaned by sandblasting, so that its condition could be checked for uniformity and smoothness. Where the specified upstream run of 100 pipe diam. resulted in a section of pipe longer than the normal length (20 to 22 ft.) two sections were butt-welded together. When possible the weld was ground flush with the inside of the pipe. In all cases the weld was installed the full pipe length distance, i.e., 20 to 22 ft., from the orifice.

From Fig. 1. it will be noted that the piping of the dual meter installations was so arranged that either orifice and attendant pipe runs could be by-passed and removed from service for inspection or changes while the other meter remained in operation. The by-pass line around each orifice was equipped with double block valves separated by a short piping spool piece. When the orifice meter was in service, a spool piece fabricated of blind flanges with ½-in. holes drilled in the pipe (see Detail "A", Fig. 1) was installed between the cocks, which readily demonstrated that no fluid was going through the by-pass. A second spool piece identical in length and of normal construction replaced the perforated spool when it was necessary to use the by-pass.

In Fig. 1 the arrows show the normal flow through the dual meter installation. To by-pass Orifice "A", the perforated portion of Double Pipe Spool Piece "G" is removed and the conventional spool is substituted and the adjacent block valves opened. Block Valves "C" and "D" are closed and the orifice and meter runs are available for maintenance. Orifice "B" is by-passed by switching Double Spool Piece "H", opening the adjacent block valves and closing Block Valves "E" and "F".

The entire piping assembly was placed in a horizontal position at a height of about 7 ft. above the grade level. This was done in order that the seal pots and meter body could be installed beneath the orifice and still permit the meter to be at a convenient height for reading the recording chart and doing maintenance work.

The orifice plates were made of ⅛-in. thick stainless steel and conformed with the specifications of the American Society of Mechanical Engineers. Before each plate was installed, the bore diameter was carefully measured and checked for sharpness of the upstream edge, roundness, and perpendicularity to the face of the orifice plate. In addition, a check was made to see that the plate was flat and that sufficient clearance existed between the outside orifice diameter and the flange bolt circle to prevent buckling once the plate reached line operating temperature.

It was expected that the flows through the meters might vary. To take care of variations and at the same time provide accurate measurements, all orifices were designed on the basis of 100-in. range tubes. This afforded the flexibility of changing to a 50 or 200-in. range tube without sacrificing accuracy or changing orifice plates. While discharge coefficients for Beta ratios (ratio of orifice diameter to inside pipe diameter) are readily available between the limits of 0.1 to 0.7-0.75, an effort was made to keep the Beta ratios for the orifices used in the dual metering installations within the limits of 0.25 to 0.6, since some of the discharge coefficients(1) outside these limits are extrapolated rather than experimentally determined values. In evaluating Beta the inside diameter of the pipe was calipered at a distance of 4 diam. preceding the orifice, and the arithmetic mean of the values obtained was used as the inside pipe diameter.

The orifice flanges were the threaded type, with the pipe inserted so that its end was flush with the face of the flange. The flanges were installed with the pressure taps in the horizontal position. The pipe was examined and any burrs resulting from these operations were removed. Care was taken in the installation of the orifice to see that the gasket material did not project into the pipe, that the gaskets and orifice plate were properly centered, and that the flange bolts were tightened evenly to prevent buckling of the plate.

In the dual meter installations local recording mercury meters were used; neither remote recording or flow control type instruments were permitted because of the greater error inherent in using them. Each metering assembly was equipped with 6-in. diam. seal pots using water as the sealing liquid. The piping manifolds on the meters and seal pots were designed to facilitate zeroing and calibration of the meters. The length of these piping manifolds was kept to a minimum.

The necessary facilities for obtaining the pressure, temperature, and a composite sample of the liquid hydrocarbon were provided at least 20 diam. downstream from the second orifice. The line diameter was increased to at least 6 in. at the point where the thermowell was installed to provide adequate immersion of the temperature measuring device. The piping of the 4 meter installations under consideration in this paper was arranged so that the orifices, seal pots, and recorders were enclosed in a house which could be heated during cold weather and, thereby, minimize temperature changes and provid maximum convenience for meter operation and maintenance. The pressure and sample connections were extended into the house.

(1) The coefficients of discharge of the American Society of Mechanical Engineers were used.

The more important physical characteristics of the 4 dual metering installations used in obtaining the data for this study are shown in Table 1.

Maintenance of Installations

A maintenance schedule was specified for the dual metering installations which included the following: 1—a daily zero check of each meter under operating pressure, 2—a complete check of the meter followed by calibration once every three months, and 3—examination of the orifice plates and upstream and downstream meter runs at intervals depending on the service of the meter. The meters were given complete checks and calibrations more often than the scheduled 3 months if their daily records or other reliable methods indicated one or both meters to be in error. It was the practice to overhaul or calibrate the meters when the deviation between them exceeded the specified maximum tolerance of 3% over a period of two or more consecutive days.

It is believed that the maintenance schedule was adequate and that even if considerably more effort had been expended in maintaining the meters, closer agreement could not have been obtained between the meters. This is based on the fact that it was seldom necessary to adjust these meters on the daily zero check or the 3 months calibration.

Selection of Data

The records obtained during certain periods from January, 1944, through December, 1948, on 4 of the dual orifice meter installations were chosen for this study. These particular installations were selected because of their freedom from pulsations and wide variations in flow, which make good measurements very difficult. In examining the charts from these installations, it was realized that certain of the charts would have to be excluded if the study were to be considered representative of normal meter performance. Thus, charts were excluded for any of the following reasons:

1—Either one or both of the charts were incomplete due to plant shutdown, calibration of the meter, clock stopping, failure of pen to ink, etc.

2—The flow pen reading was below 3 on the 10-division square root chart.

3—The indicated flow rate was not in agreement with rates based on known process outputs or other reliable secondary checks.

Charts with flow pen readings below 3 were not included because of the high percentage error encountered in planimetering charts with low pen readings. When it was anticipated that the pen reading would be as low as 3 for any period of time, the range tube or orifice plate changes necessary to give higher pen readings were made. Exclusions for the reasons mentioned in the third category were infrequent (being zero for some of the installations) and were usually due to leakage of the seal fluid from the pots or to blowing the mercury from the meter.

It was found necessary to exclude only about 10% of the charts obtained for the periods under consideration for any of the reasons previously stated. The total of 2544 sets of dual meter charts which remained after the exclusions were used as a basis for this study.

The 10-division square root chart records from the dual meters were

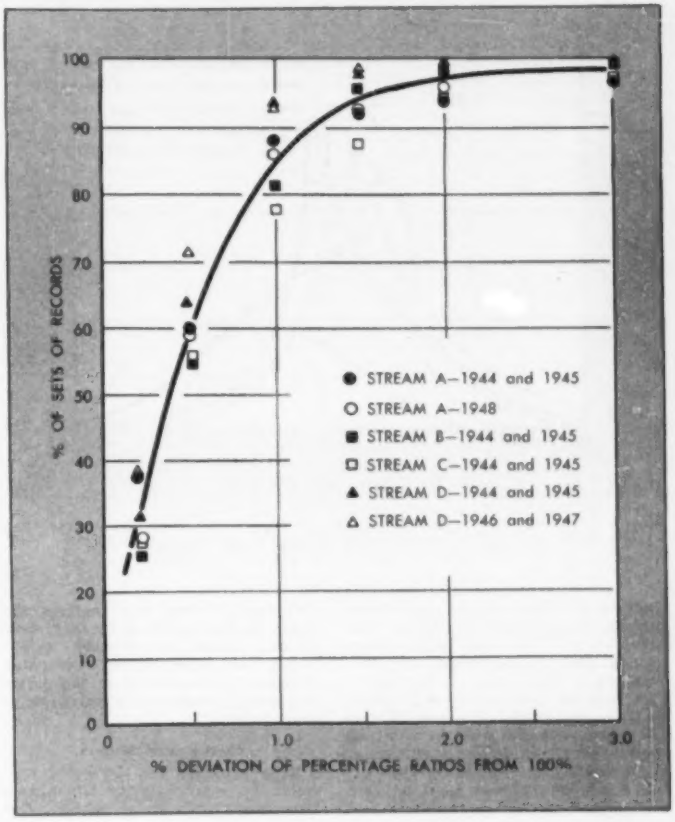


FIG. 3—Deviation of dual meter agreement ratios from 100%. (Materials identified as Streams A, B, C, and D are shown in Table 2)

Table 1—Physical Characteristics of Dual Meter Installations

Stream*	Nominal Line Size, D_1 Inches	Measured Orifice Size, D_2 Inches	Beta Ratio D_2/D_1	Range Tube Size Inches of Water	Approximate Flow Pen Reading**
A—Isobutylene Product (Jan., 1944—April, 1945)	3	1.100	0.359	100	6
A—Isobutylene Product (Jan., 1948—Dec., 1948)	3	1.228	0.400	50 & 100	5-7
B—n-Butylene Feed (Jan., 1944—April, 1945)	3	1.300	0.424	100	5
C—Mixed Butylenes (Jan., 1944—April, 1945)	3	0.883	0.289	100	6
D—Butadiene Product (Jan., 1944—April, 1945)	6	3.000	0.495	100	5
D—Butadiene Product (Jan., 1946—Sept., 1947)	6	3.000	0.495	100	5

* A, B, C, and D represent the streams measured by 4 dual meter installations from which data were obtained.

** Reading on a 10-division square root type chart used on the flow recorders.

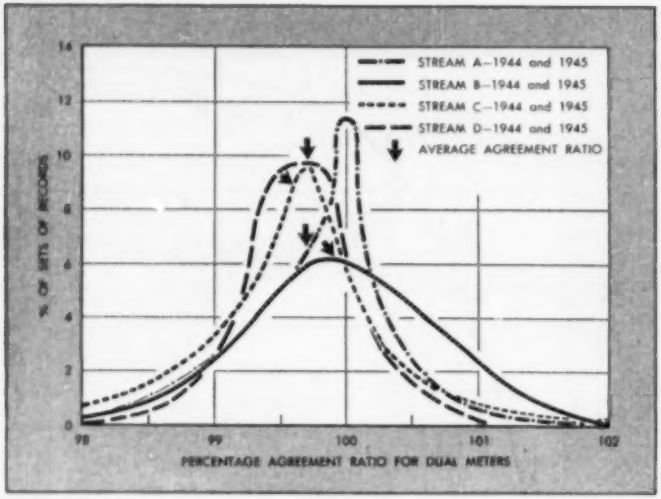

STREAM A—1944 and 1945
STREAM B—1944 and 1945
STREAM C—1944 and 1945
STREAM D—1944 and 1945
AVERAGE AGREEMENT RATIO
% OF SETS OF RECORDS
PERCENTAGE AGREEMENT RATIO FOR DUAL METERS

FIG. 4—Frequency distribution curves for the agreement ratios of the four dual meter installations (Streams A, B, C, and D are shown in Table 1)

integrated with square root type planimeters provided by the meter manufacturer for use with these charts. Each of the charts was integrated by two clerks. If the deviation between the readings obtained by the two clerks did not exceed 0.03 (i.e., approximately 1% at a chart reading of 3 and 0.4% at a chart reading of 8), the average of the two readings was used as the final value of the pen reading for the chart. When the readings did differ by more than 0.03, they were checked until satisfactory agreements were obtained. However, this was seldom necessary, as the deviation was normally less than the maximum allowed.

Precision of Meters

In determining the degree of precision or reproducibility which can be expected of orifice meters, the 2544 sets of charts were used to calculate percentage agreement ratios between the dual meters. The agreement ratios were computed in all cases by dividing the chart reading of the first meter in the installation by the chart reading of the second and multiplying by 100 to obtain percentages expressed to the nearest 0.1%. The resulting figures were used as a measure of the precision of the meters. Table 2 shows the number of sets of records obtained, the average, minimum, and maximum agreement ratios, and the percentage of the sets of records for which the agreement ratio fell within prescribed ranges.

It is interesting to note that "Stream A" during the period January, 1944, through April, 1945, was the only one of the installations for which the largest deviation exceeded 5% (agreement ratio of 95 or 105%), and for that installation the deviation exceeded the maximum allowable deviation of 3% only 2.8% of the time. Data obtained on this same installation for the year 1948 showed a maximum deviation of 3.2%. These data serve to illustrate the degree of precision or reproducibility which can be achieved with properly installed and maintained orifice meters. The curve in Fig. 3, which is based on Table 2, further emphasizes the precision possible, showing that for 85% of the 2544 sets of records the deviation was 1% or less and that for 99.2% of the records the deviation was 3% or less.

The percentage agreement ratio data for the 4 dual installations during the period January, 1944, through April, 1945, are shown on Fig. 4 and indicate the precision or reproducibility of each of the installations. In Fig. 5 frequency distributions are used to compare the precision of the "Stream A" dual installation during the period January, 1944, through April, 1945, with the year 1948. The general agreement in the shape of the two curves and the fact that the average agreement ratio was 99.7% during the first period and 99.5% during the second indicate there was no appreciable change in the precision of the installation over the four-year period.

As can be seen from Figs. 4 and 5, most frequent percentage ratio is also very nearly the average percentage ratio. This is characteristic of the frequency distribution type curve and is indicative that at least a certain amount of the disagreement in the measurements obtained with the two meters on the same stream is due to random error in any of several items entering into the determination of the meter records. The fact that the average percentage ratio and the most frequent percentage ratio are displaced from 100% is evidence of there being a

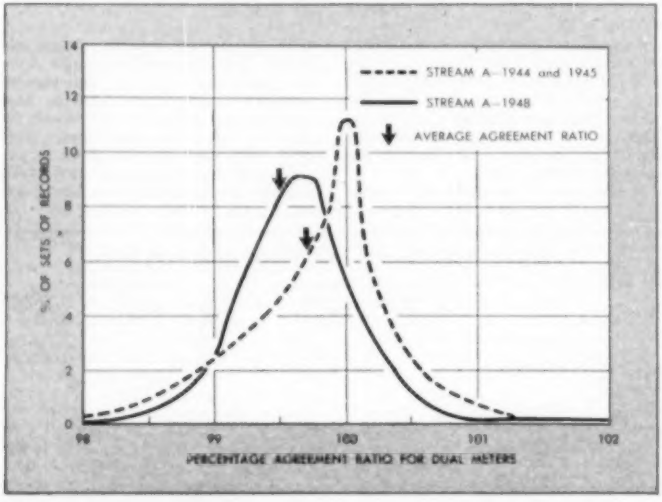

STREAM A—1944 and 1945
STREAM A—1948
AVERAGE AGREEMENT RATIO
% OF SETS OF RECORDS
PERCENTAGE AGREEMENT RATIO FOR DUAL METERS

FIG. 5—Frequency distribution curves comparing precision of a dual meter installation during two periods (Stream A is shown in Table 1)

slight physical difference between the two individual meter setups comprising the dual installations, or a slight difference in the stream conditions at the two meters. It will be noted that in all cases the average agreement ratio was slightly below 100%, meaning that on the average the first meter read lower than the second. No explanation has been found.

Accuracy of Meters

To establish the accuracy of a dual orifice meter installation, the quantities as determined by the dual meter installation on "Stream D" were compared to the quantities as determined from gauge readings on calibrated receiving drums. The recording meters used in this service were provided with 2-hour clocks to aid in obtaining accurate measurements, since each movement was of approximately 1 hour and 45 minutes duration. The hydrocarbon stream delivered through these meters was received in 10 ft. diam. by 50 ft. long horizontal drums equipped with gauge glasses which could be read to the nearest $\frac{1}{8}$ in. Since the level change in each shipment was about 5 ft., the probable error would be in the order of $\pm 0.2\%$. The shipments were scheduled so that the opening and closing gauges on the drums were at about the same level for each shipment, and the drums were blocked off from all other equipment.

The period January, 1946, through September, 1947, was chosen for this phase of the study, as the receiving drums were carefully water-calibrated in the latter part of 1945. In the bottom line of Table 2 are shown the agreement ratios between the average of the two meters and gauges on the receiving drums for 580 hydrocarbon movements made in this period from January, 1946, to September, 1947. It can be seen that for 61.4% of the movements the deviations between the average of the dual meters and the drum gauges was 1% or less and that for 99.6% of the movements the deviation was 3% or less. The average agreement of 99.3% between the dual meters and the drum gauges is indicative of the accuracy of the dual meter installation. It is interesting to note that during this period the average agreement between the two meters was 99.9%.

On Fig. 6 are presented smooth frequency distributions showing the percentage agreements between the two meter readings and between the average of the meter readings and the drum gauges. It will be noted that the two curves are, in general, of the same type but that the curve showing the agreement between the average of the meters and the drum gauges is flatter. By virtue of the fact that the curve showing the agreement between the two meters is

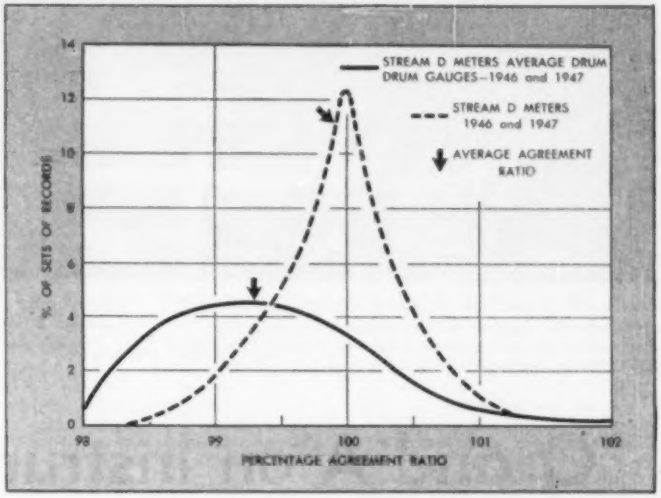


FIG. 6—Frequency distribution curve illustrating the accuracy of a dual meter installation (Stream D is shown in Table 1)

quite peaked, it is not unreasonable to conclude that errors are more frequently obtained in taking gauge readings and, therefore, that the precision of the orifice meters is greater than that of reading the drum gauges.

Conclusions

From this study the following conclusions were reached:

1—The dual orifice meters installed as described herein are satisfactory for measuring liquid hydrocarbon streams.

2—The deviation between dual orifice meters which are properly installed and adequately maintained can be held at 1% or less for 85% of the time and 3% or less for more than 99% of the time with an average deviation in the order 0.1 to 0.5%.

3—The precision of orifice meter installations can be maintained over long periods of time with proper maintenance.

4—The accuracy using dual orifice meters can be maintained within 1% or less for about 60% of the time and within 3% or less for more than 99% of the time, with an average accuracy within 1%.

5—The measurements of the dual orifice meters on "Stream D" were more precise than those of the gauges on the water-calibrated receiving drums on the same stream.

Acknowledgment

The author acknowledges the permission of the Reconstruction Finance Corp., Office of Rubber Reserve, to publish this information and the helpful assistance of the Standard Oil Development Co. in the preparation of the paper.

Table 2—Summary of Precision and Accuracy Results Obtained With Dual Orifice Installations

Stream	No. of Sets of Records	Agreement Ratios Avg.	Min.	Max.	Per Cent of Records for Which Agreement Ratio Is That Within the Indicated Range 99.8–100.2	99.5–100.5	99.0–101.0	98.5–101.5	98.0–102.0	97.0–103.0
A*—Isobutylene Product (Jan., 1944—April, 1945)	450	99.7	87.3	102.8	37.4	59.9	80.8	92.0	94.2	97.2
A*—Isobutylene Product (Jan., 1948—Dec., 1948)	329	99.5	96.8	101.9	28.1	58.8	85.9	92.5	96.1	99.7
B*—n-Butylene Feed (Jan., 1944—April, 1945)	410	99.9	95.9	102.4	25.5	54.4	81.2	95.5	98.9	99.6
C*—Mixed Butylenes (Jan., 1944—April, 1945)	361	99.6	95.1	103.9	27.8	55.8	77.4	87.4	94.7	98.1
D*—Butadiene Product (Jan., 1944—April, 1945)	413	99.7	97.8	102.2	31.5	63.3	93.6	97.9	99.8	100.0
D*—Butadiene Product (Jan., 1946—Sept., 1947)	581	99.9	98.4	102.9	38.3	70.9	93.1	98.6	99.6	100.0
D**—Butadiene Product (Jan., 1946—Sept., 1947)	580	99.3	96.5	104.3	16.9	33.3	61.4	81.9	94.6	99.6

* Represents data for agreement ratios between the dual meters.

** Represents data for agreement ratio between average of the two meters on this stream and corresponding records for a calibrated receiving drum.

PANEL OF EXPERTS on all phases of instrumentation assemble for the Question & Answer session at Texas A & M's Symposium on Instrumentation for the Process Industries. From left to right: B. W. Thomas, Humble; Givens, La Gloria Corp.; Clarridge, Taylor Instrument; Marchment, Evershed & Vignoles, London; Novak, du Pont; Hart, Dow; Rockwell, Mason-Nielan, and King, Dow

Q and A on Instrumentation

One of the principal features of the Symposium on Instrumentation for the Process Industries, sponsored by the Agricultural & Mechanical College of Texas at College Station Oct. 11-13, was a three-hour "Question and Answer Session." For this session a question-box was maintained during the preceding sessions of the meeting. Questions from this box, plus extemporaneous questions from the floor during the session, were then asked of a panel of experts composed of the symposium speakers.

The material presented on this and the following pages has been prepared from selected portions of an on-the-spot wire recording of the session, made by PETROLEUM PROCESSING's Southwestern Editor, Dave Thornton. Preference has been given to those questions and answers deemed of the most general interest to plant men in refineries and natural gasoline plants.

The panel of experts included: Dr. B. W. Thomas, Humble Oil & Refining Co., Baytown, Texas; Homer C. Givens, La Gloria Corp., Falfurrias, Texas; R. E. Clarridge, Taylor Instrument Co., Rochester, N. Y.; W. T. Marchment, Evershed and Vignoles, Ltd., Chiswick, London, England; A. V. Novak, E. I. du Pont de Nemours & Co., Orange, Texas; Porter Hart and R. C. King, Dow Chemical Co., Freeport, Texas, and R. A. Rockwell, Mason-Neilan Regulator Co., Boston.

Q—What has been and is being done on streamlining control valve bodies to reduce erosion of internal surfaces of the body due to turbulence?

A—Rockwell—It is difficult to make any general statements about this. Streamlining bodies is a matter of design to make them efficient. As pointed out in my paper, the angle-type body has a high efficiency and is very streamlined. Possibly you have seen valves in cutaway section showing the streamlined characteristics. By passing some colored smoke or colored vapor through it you see the smooth streamlined effect as the smoke drifts through.

But, what we are confronted with in valves, in most instances, is taking high pressure drops. When high pressure drops are taken you do not get drifting smoke through them. There is a great deal of turbulence. There are some indications that it is not always desirable to have streamlined bodies. Particularly in water service, there are indications that when very streamlined bodies and very smooth flows are encountered there is enormous cavitation, extreme noise and great vibration.

* * *

Q—Please comment on the application of microwave spectrometry to continuous analysis. Can hydrocarbons be detected? Could the method be used for both gas and liquid streams? How complex would the equipment be?

A—Thomas—Our knowledge of the application of microwave spectrometry to even laboratory studies is very certainly limited to date. We do have quite a few laboratories throughout the country developing microwave equipment but, to date, it has not been applied too satisfactorily for the analysis of materials, either chemical or petroleum types.

I mentioned this as a possible future development for continuous analyzers. But we must study these instruments in the laboratory first to prove there is a measurement possible which means something before we can think of developing continuous analyzers. I am sure this development is several years in the future, at least.

I tried to point out that the type of compounds which can be detected by microwave spectroscopy is the polar compounds—i.e., compounds in which oxygen, nitrogen and perhaps sulfur are involved. The microwave spectra of hydrocarbons are relatively small. They do not absorb microwave energy nearly to the extent they absorb infrared or ultra violet and this further complicates the problem.

* * *

Q—What do you mean by close-coupled loops?

A—Novak—Briefly, close-coupled loops are control systems in which the detecting element, the controller and the controlled valve all are physically located in a very small area in order to reduce transfer lags.

Close control loops comprise ele-

ments which are closely related and physically in close proximity. The whole advantage of reducing the time constant of the system is to secure speedy response—getting the process to follow the detected error quickly. The shorter the time constant the better is the frequency response and the smaller the phase angles encountered as far as the shift is concerned in the control loop. This subject is rather controversial and much more could be said on this.

* * *

Q—In close-coupled control loops the lag in the valve diaphragm may be a large part of the total lag in the circuit. Instrument manufacturers are turning out improved controllers attempting to reduce lags. What is the valve industry doing about this problem?

A—**Rockwell**—It is only very, very recently that we have been receiving any demand from industry to increase the valve opening rate. In the past, with conventional reset and proportional controllers, controlling most processes, the speed of the valve was relatively unimportant, provided the valve speed always was greater than the rate at which the process variable would change.

Now, with some of the new control responses such as derivative in various parts of the instrument circuit, there possibly is an attempt to kick the valve around. We may be confronted with the problem of providing some means of increasing the speed of valve opening and closing and, at the same time with conventional valve operators, of securing enough stability to avoid "pumping."

* * *

Q—Is there an instrument available commercially which will continuously record H_2S content down to $\frac{1}{4}$-gr. per 100 cu. ft. in a dry hydrocarbon gas? If so, what principle is employed?

A—**Thomas**—I am not sure what part per million that would be. There is an instrument available—not for purchase, but for rent from Consolidated Engineering Corp.—which employs the principle of titration. It will determine H_2S to less than 1 ppm. and continuously record that amount. In fact, it will measure total reactive sulfur and can be arranged to measure total H_2S, total SO_2 or mercaptan sulfur.

* * *

Q—Why not install a motor valve in the fuel gas line to the engine instead of having the diaphragm motor valve setting the governor for speed control?

A—**Givens**—It is due to the sudden demands of a sudden load change. It is feasible, however, and some people are doing it, although engine manufacturers will tell you it is not. Their belief is due to the fact that field pressures, from which you are controlling speed, do not change very rapidly. It requires several minutes for the pressure to build up from, say, zero to 8 psi. or back from 8 psi. to zero. But it is possible to control satisfactorily in this way.

* * *

Q—Is the use of a valve positioner the solution to the problem of unbalanced forces in ordinary control valves?

A—**Rockwell** — The positioner does nothing towards taking care of the unbalanced force resulting from velocity effects in the body of the valve. The one thing it may do for the whole control setup is to maintain the relation between the instrument signal and the position of the valve. Thereby the positioner itself applies to the diaphragm motor whatever force is required to put it into that position.

* * *

Q—What is the effect of flashing a liquid to vapor in passing through a control valve, due to pressure drop, on the unbalanced forces acting on the valve plug? Can an allowance be made for this effect?

A—**Rockwell**—Not only am I unable to make any allowance; I am unable to make any answer. There is too much we do not know about flashing of fluids; we do not know which way the curve goes, and hardly how to determine control valve sizes.

Practically, the only way we operate is by playing safe and carrying expanded bodies. What effect these things have on unbalanced force reactions is beyond our scope at present. We now are dealing largely with liquids. We hope to do more with compressible fluids later. The transitory conditions from liquids to compressible fluids is certainly something for much later consideration.

* * *

Q—Why are you so willing to give up graphic instruments for a graphic panel?

A—**Novak**—We are not giving up graphic instruments—recorders—which I assume the questioner means. We merely are consolidating and relocating them. By consolidation we save space and put them there for reference if needed.

Many of the people operating graphics say that, for routine day-to-day use they are not needed, but they are there. Records are needed for start-ups, for instrument line-ups (that is where instrument men are mostly involved) and for detecting those things causing upsets in the immediate time past. This also is one reason for charts, while another is for supervisory review in following the work of past shifts.

Q—How are unbalanced forces in valves predicted, when they vary with pressure drop changes?

A—**Rockwell**—The only exact information available is through the range which we tested; 85 to 90 psi. for both double—and single—seated valves. All our curves were plotted on the basis of 100.

We ran a series of tests with plugs of different lifts and at different pressure drops to correlate the information. Through the ranges in which we used our assumptions, we found the unbalanced force directly proportional to the pressure drop. With uncompressible fluids the static pressure again would come in, as it would affect the density (mass velocity) of the material being handled.

* * *

Q—Is it considered an advantage in having controllers inside the control room, where they are under proper attention, as against locating them outside, in the plant?

A—**Novak**—The advantages of working on controllers in an air-conditioned control room vs. working on them in the field cannot be denied. Rather, it is a case of choosing which of two situations are of the most advantage.

In the pneumatic system the advantages to be gained by close-coupled control systems must be weighed against decentralization of control units. In cases where the answer indicates there is little to be gained, then naturally the controllers should be in the control room. The graphic panel allows for that.

Where advantages of close-coupled systems and decreased time constants in the system are desirable, when they have a controlling effect, it is a cheap price to pay by actually locating the controller where it is needed.

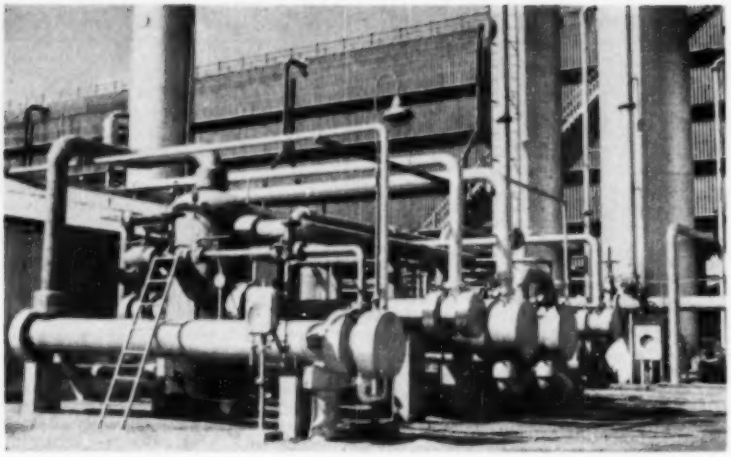
* * *

Q—Can a continuous mass spectrometer for process streams continuously analyze a gaseous hydrocarbon stream for three or more components?

A—**Thomas**—The instrument is called a "process control mass spectrometer," manufactured by Consolidated Engineering Corp. I believe it now is equipped for recording three masses consecutively.

The masses are preselected and not necessarily adjacent in a mass spectrum. Therefore it should be possible to look at more than three components.

The measurement is that of the total ion current at one particular mass. This may not be representative of that one component alone, because there always is interference. But you can tell by the general increase or decrease of that particular ion whether or not the major contributor to that ion is increasing or decreasing.



MODERN EQUIPMENT for today's natural gasoline plants is typified by this propane refrigeration unit. It is located in the Wilmington Gasoline Co.'s plant at Terminal Island, Calif.

Natural Gasoline

Today's Equipment Is Tailored To Gasoline Plant's Needs

From Reports Presented at 25th Annual Meeting California Natural Gasoline Assn., Los Angeles, Nov. 9-10.

THE development of specialized equipment and methods for processing liquids from natural gas has reached the point where the proper selection and maintenance of equipment is paramount in the profitable operation of gasoline plants.

These improved techniques in the natural gasoline industry were featured in papers and discussions given at the Silver Anniversary meeting of the California Natural Gasoline Assn., in Los Angeles Nov. 9-10. As recently as 20 years ago, it was brought out, the majority of gasoline plants were of the simple compression type, with "Miles of leather belting" from a gas engine driven line shaft operating the compressors, pumps and auxiliary equipment. Today's multi-product plant was described as a complex unit, its design representing an engineering feat, and "doing everything and anything for 6 to 8 cents a gallon".

In the early plants, the equipment was largely makeshift, being originally designed and built for other uses. Under these conditions it was bought oversize or with considerable capacity in excess of the anticipated gasoline plant needs. Considerable leeway was possible in the care of the equipment. In fact, operators were required to use considerable ingenuity to keep compressors, pumps and so on working, and the plant on schedule.

Today, however, the higher costs required for the equipment, together with the improved technology in natural gasoline manufacturing, have resulted in the equipment being bought and installed for specific operations and with little tolerance above actual design requirements. The result of these changes in design and rating, as was brought out at the CNGA meeting, is that the gasoline plant equipment must be properly operated and maintained to deliver what it was designed and installed to do.

For example, up to within a few years ago, it was stated, cooling equipment of from 20 to 30% oversize was installed in gasoline plants, whereas today it is only 1 to 2% above the plant's design requirements, sometimes not that much.

The development of special types of pumps for gasoline plants, including the close clearance simplex and the process type centrifugal, allows the gasoline plant manager latitude in the selection of pumps for specific uses. However, since the pump is one item subject to continuous wear, proper selection and maintenance is imperative if unduly high maintenance costs are to be avoided.

The adaptation of multi-cylinder gasoline engines for supplying power for auxiliary pumps and other uses, a relatively new development, has provided gasoline plants an economical form of drive for various small and medium power requirements. However, the application of these pumps, burning gas or LPG, was found to differ somewhat from their automotive use and their design has already been improved for gasoline plant use. Standards for the proper selection and application of this type of equipment must be set up by the plant engineers, if the life of the engines is to be extended.

At the CNGA meeting, the factors and conditions which plant operators must consider in their selection of equipment and materials, were discussed at two forums arranged as an innovation of the CNGA meetings. Forum No. 1, on "Efficient Operation and Maintenance of Plant

Equipment", was conducted by J. B. Taylor, Signal Oil & Gas Co. Forum No. 4, on "Progress in Gasoline Plant Equipment and Design", was conducted by M. W. Kibre, General Petroleum Corp., and L. V. Leonard, Shell Oil Co. Two other forums were held, on "The Application of Chemical and Process Engineering Principles to the Efficient Design and Operation of Natural Gas Processing Plants", and on "The Role of the Chemist and Laboratory in Efficient Natural Gas Operations". Following is a review in condensed form of the reports given at the forums on gasoline plant design and equipment:

COOLING EQUIPMENT

By George H. Dieter
Fluor Corp., Ltd.

THE mechanical draft cooling tower was first used in natural gasoline plants in the early 1940s and it is standard equipment in many instances today, although atmospheric towers are still used to some extent in various localities.

The mechanical draft tower, either forced or induced draft, as a general rule requires less ground area than the atmospheric tower and the area required is in a more compact form. It can be installed much closer to plant equipment without affecting normal plant maintenance, since wind blown water loss from the tower is eliminated, and the water loss, except that lost in evaporative cooling, is limited to that carried over with the discharge air; i.e., approximately 0.2% of the water circulating rate. The overall installed cost of the mechanical draft cooling tower, including basin, process and water piping, is less than most large aerator tower installations required for the same work.

It is possible in the mechanical draft tower to cool the water to a temperature much closer to the wet bulb than is economically possible with an atmospheric tower. It also lends itself to close temperature control of fractionating equipment, since the temperature of water off the tower varies only with the wet bulb temperature of the air entering the tower, providing that the fan speed and water circulation rate remain unchanged.

In the late 1930s, some operators of internal combustion engines on gas transmission lines installed air-cooled equipment for cooling the jacket water. The equipment consisted of a radiator type section with finned surface, across which a blast of air was blown by a separately driven propeller type fan. Until 1942 this equipment was limited to small installations, and no applications were made other than for jacket water cooling, steam condensing and some gas cooling. Later, however, as a result of water shortages developing in some parts of the U. S., several manufacturers developed such equipment for use in processing plants.

Today, there are a large number of installations of air cooled equipment in natural gasoline plants, in services ranging from jacket water cooling to oil cooling and hydrocarbon condenser service. In at least one plant air cooling is used exclusively and it is reported performing as expected.

The use of air cooled equipment eliminates all water cooling loss entirely for that portion of the heat load which is dissipated within the unit, since only air is used as the cooling medium. While the air cooled heat exchanger is not the answer to all cooling problems, it is generally believed that this equipment can be utilized more effectively in gasoline plants than it has in the past. The ideal plant will, no doubt, be one in which both air cooled heat exchangers and water cooling towers are used to their best respective advantages.

PUMPING TRENDS

By Paul Armstrong
Union Steam Pump Sales Co.

WITH the change from duplex to simplex steam pumps as applied in natural gasoline plant operation, refinements were made in the fluid end, and the so-called close clearance pump was developed. The volumetric efficiency was improved and the working pressure of the cylinder was 450 to 500 lbs.

Later refinements were developed on the West Coast. The early pumps had iron piston rings. These were unsatisfactory for handling the lighter fractionations and, so the micarta and later the graphitized micarta piston rings were developed. The stuffing boxes were extra deep and were provided with a lantern ring for grease lubrication. The use of a separate compartment of the force feed mechanical lubricator, which gave continuous lubrication to the stuffing box, was recognized here.

By 1940 the pump manufacturers started developing the so-called process type centrifugal, which has found such widespread use in the natural gasoline and petroleum refining industries. This type was designed to give a low entrance loss into the pump and to be more or less self-clearing of vapors. It is rigidly constructed and has the advantage, in the smaller sizes, of having only one stuffing box.

Stuffing boxes continued to give trouble, particularly on light products. Many elaborate devices were made, some of which were effective, but their cost seems out of proportion to the price of the pump. The idea of a mechanical seal developed gradually and it has taken years of development on the part of the seal manufacturers and willingness on the part of operators to experiment, to bring the seal to its present stage of development. Many gasoline plants now use seals entirely for their light hydrocarbon centrifugals, but they must be used on properly designed pumps if they are to be effective.

In judging the present state of the centrifugal pump industry, it is apparent a big improvement has been made in the so-called process pumps designed to handle volatile liquids. These pumps are designed for low entrance loss, that is, to operate with a low NPSH (net positive suction head), but in general low NPSH also means lower efficiency. These pumps are of two types. One is for medium pressures suitable for gasoline transfer pumps and so forth; the other is a much heavier design casing, usually with water-jacketed boxes, and is suitable for high suction pressures such as reflux service or for high total pressure. The light weight pump should not be used in place of the heavy-duty pump. The result is much higher maintenance cost which will soon overcome any difference in initial cost.

In the natural gasoline industry there has been a big improvement in multi-stage pumps used for 500 and 800-lb. absorbers. The original pumps were intended for boiler feed service and, even though they might show higher efficiency, they required a great deal of maintenance. The present design pumps are more rugged. The so-called deep well type pump has been redesigned and is now used as a vertical cooling tower pump. It is enclosed in an external housing and used especially to handle small capacities at high pressures. It has the advantage that suction can be at or below ground level.

It is possible, with the advent of the gas turbine and high speed turbines, to operate centrifugals at much higher speeds. However, an increase in speed can only be obtained by an increase in suction pressure. This relationship would seem to preclude the use of centrifugal pumps in normal gasoline plant operations at speeds appreciably above 4000 RPM.

PERFORATED PLATE TRAY TOWERS

By H. R. Marsh
J. B. Gill Co.

PERFORMANCE was reported on a number of perforated plate tray towers of the cross flow type, as available from towers in several plants which have been in operation two years or longer. The data showed that, when properly designed, the perforated trays are as efficient in every respect as the conventional bubble cap trays in common use; that they can be designed to operate over as wide a range of loading as conventional trays, in some instances over a wider range with greater overall efficiency; they are of extremely simple mechanical design, and plate material can easily be selected to meet corrosion and other special requirements.

An example was presented of a plant utilizing specially designed perforated plate tray towers. Over 2700 wells are tied into the wet gas gathering system of the plant, located in East Texas. The well flowing schedule is such that severe volume swings of short periods occur in the plant input during 24 hours, the swings ranging through these short periods from 7,000 MCF/day rate to 17,000 plus MCF/day rate.

The plant was built to replace an existing unit and with the express purpose of improving overall propane recovery to 90% plus. It consisted of new absorption and distillation cycles.

The towers and the plant were especially designed for the condition outlined and the plant was so instrumented that the volume swings as well as the regularly occurring composition swings are automatically handled. The plant normally recovers in excess of 90% of the propane in the incoming field gas on a daily basis and, during summer months, the monthly average recovery of propane has been as high as 96%.

The new unit included an absorber with water-cooled special base absorber cycle and 3 water-cooled intercoolers, a rich oil rectifier, a reabsorber with a special base absorber cooler and two water intercoolers, a single stage still operating at 125 psig., all of perforated plate tray design of the cross flow type. Also incorporated was an existing conventional bubble column for compressor plant condensate deethanization. The former product deethanizer unit was revised and is operated as a depropanizer and the regular stabilizers (two towers) were revised to make LPG and natural gasoline. Other units, such as compressor plant, steam plant and water cooling facilities, were utilized as installed.

The rich-oil rectifier employing lean oil to rich oil heating and at times some propane stripping is so instrumented that it automatically follows oil rate changes and composition swing. Thus, the perforated plate tray tower is called on to operate over wide ranges of loading. However, 90% propane retention is maintained and overall plant recoveries are well over 90%.

The rich-oil rectifier overhead vapors and the compressor plant condensate deethanizer overhead vapors are charged to the reabsorber, which is of similar design to the main absorber and operating with the same recoveries.

The still is a single-stage 125 psig. unit, with 4 tray combinations and 3 operating sections; stripping, oil fractionating, and gasoline fractionating. The feed comes from the plant lean oil to rich oil heat exchange, direct to the feed tray of the tower. Some trays below this feed tray the oil is withdrawn and sent to a fired heater, heated and returned to the column. Steam is introduced at the tower base.

The still follows the extreme changes of charge volume, also composition swing 3 times daily and, under these difficult conditions, is capable of unusually sharp fractionation. It maintains a lean oil in the system of 170 to 175 mol weight and approximately 300° F. initial boiling point. At the same time the still fractionates so sharply it is able to provide the necessary lean oil makeup from the heavy ends of the incoming field gas. The steam rate is less than 0.1 lb. per gallon of lean oil circulated.

COMPRESSORS, REFRIGERATION

By W. G. Palmer
Refinery Maintenance Co.

HEAVY-DUTY straight-line compressors are being supplanted in part by newer designs having higher speeds. In the same services speeds have been increased from 80 to 300 RPM (600 RPM in the small portable units). Horsepower per unit has risen from 80 to 400 to 2400. All this has been brought about by the V-type and in-line designs. Foundation requirements as well as floor space have been reduced about one third. Lube oil cooling and jacket water cooling systems have been improved to keep pace with the redesign of the engines. Effective methods have been developed to properly distribute the water through the engine jackets by means of baffles and jets. Vapor phase cooling, although now available, is used in very restricted applications.

Power cylinders are arranged in the straight line up to 8 cylinders, on the V-type 2 to 12 cylinders. Supercharging is available. Fuel injection is standard equipment on most two-cycle machines, resulting in better fuel economy.

Refrigeration has been applied to obtain higher propane recoveries. In the newer plants, with stills operating at about 100 psig. and totally condensing, refrigeration is required on the wet gas and lean oil. In addition, a refrigerated absorber-intercooler is sometimes used. In the older plants operating with approximately 50-lb. still pressure, still overhead chillers are required in addition to existing water or air cooled condensing equipment to effect total condensation.

The choice of the refrigeration cycle is optional, whether compression, absorption or adsorption. Propane has been used because of its availability. However, ammonia and other refrigerants can similarly be used in these cycles.

Where existing equipment can be used or converted to the propane cycle this cycle may be advisable. However, when a new plant is contemplated it is advisable to consider an absorption type refrigeration cycle, with particular emphasis on the use of ammonia. This unit can be applied to older plants where there is sufficient exhaust steam at approximately 20 psig.

The ammonia absorption unit consists of still, reboiler, condenser, chillers, ammonia-absorber-cooler and a circulating pump to charge the still. Maintenance is nil and operation is automatic. The still reboiler serves as an exhaust steam condenser which returns distilled water to the boiler feed system.

Deethanizers represent a rather recent development in natural gasoline plant operating technique. Prior to fat oil deethanization, the total still overhead condensed and non-condensibles were passed through a fractionator operating at 400 to 450 lbs., removing the ethane and part of the propane. Present day operations deethanize the fat oil at 125 to 200 lbs. and permit the plant still and fractionators to operate totally condensing. Fat oil deethanizers can have either forced or differential head flow of the oil through side heaters.

The application of instruments in gasoline plants is unlimited. The cry that prevailed some time back was "to heck with it, use the bypass. Today, when properly applied, controls are rarely bypassed. If it were not for the perfection of present day controls, today's gasoline plants could not be operated.

PAINTS and THEIR APPLICATION

By J. M. Hebden
Socony Paint Products Co.

IN GIVING gasoline plant equipment a protective coating against corrosion, the first problem is the correct preparation of the surface to insure a reasonably clean foundation to receive the initial coat of paint. Paint must wet the metal surface completely, to accomplish the required bonding and produce a continuous coating. The quick drying primers now available call for prior thorough and complete surface preparation. This means the removal of rust, loose mill scale, grease, oil, loose paint film and other foreign matter. The fluidity of these primers does not persist for a sufficient length of time after application to permit complete wetting of the steel except under favorable surface preparation conditions. Otherwise the primer will bridge over certain irregularities in the steel, and ultimately breaks develop in the inadequately bonded paint film which allow moisture to get under the paint system and destroy it.

Our experience has been that the best method for painting over areas that could not be sandblasted is the use of penetrating oil preparation, after first cleaning the surface by wire brushing. If rust is present but firmly attached to the base metal it is not removed. The penetrating oil is liberally applied over the surface and allowed to stand from 20 minutes to 3 hours. The primer coat is then applied. The penetrating oil gives complete wetting of the primer to the metal, thereby insuring a better bond and a tighter paint film.

Galvanized iron presents another problem in the selection and application of paint since the iron base has been zinc treated. Adhesion of most primers to this metal has been found to be poor. New galvanized iron usually has an oily surface and the oil should be removed before painting, usually by washing with a suitable detergent. On repainting over galvanized iron the loose film should be removed by wire brushing before applying a galvanized primer.

In selecting the primer coating the following factors must be considered: type of base metal on which it is to be applied; use of the particular piece of equipment and the available time for painting and drying. In primers for use over iron and steel the percentage of rust inhibitive pigment should be high in order that recoating over the prime coat can be accomplished with every expectation of good adhesion.

The type of vehicle in the primer is important. If slower material, such as linseed oil, is used the primer will give excellent adhesion, due to sufficient length of time to permit good wetting of the steel. This primer, however, would have poorer impermeability to moisture due to the softer film. If a synthetic alkyd vehicle were used, the primer would have much faster drying time, harder film and better impermeability to moisture. With this type of primer, however, the poorer surface wetting or fluidity would tend to give poor adhesion. It would seem logical that the proper primer would be made up of both linseed oil and synthetic alkyds. This is generally true except in areas of high moisture content or water immersion. Here the presence of linseed oil would not give the maximum impermeability that could be realized with a straight synthetic primer.

In our experience the use of a penetrating oil preparation together with the synthetic alkyd primer more closely matches the conditions of the coastal areas. For the average normal exposure in direr areas, the slower drying, linseed oil type of primer is satisfactory.

The ability of a paint film to withstand long wearing, assuming the film is tight and has good adhesion, is proportional to the thickness of the film. It is impossible to reach this condition with one coat, therefore a multiple coat system is required. To obtain a good all purpose film, two coats of primer and two coats of finish material are recommended.

One factor that is debatable is the amount of red lead necessary for a good red lead primer. The older school of paint formulators maintains that a red lead primer should have 15 lbs. of red lead per gallon. It is our opinion that the optimum amount need not exceed 10 lbs. At the present market for red lead this would give the oil company a saving of approximately $1 per gallon and would not affect the quality of the paint film.

Selecting a primer for use over aluminum metal presents a different problem. Due to the texture of the surface most material shows poor adhesion. This may be overcome by etching the smooth aluminum with phosphoric acid solution, or in some cases having phosphoric acid present in the paint. The recommended primer for this surface is a zinc chromate primer with a phenolic varnish as the vehicle.

Galvanized iron also requires a special primer, the difficulty here being to secure adhesion. Primers pigmented principally with metallic zinc dust perform most effectively on galvanized iron, maintaining high elasticity and excellent adhesion over a long period of time.

Since the primer cannot protect the metal by itself it is recommended that the time between the priming and the finishing coat be as short as possible, a week should be the maximum. The formulation of a finish coat is one of lower pigment percentage and less reactive pigments; also, a vehicle that has good weathering characteristics, and gloss and color retention.

Synthetic alkyds have excellent weather resistance, good adhesion and pigment compatibility and excellent color and gloss retention. Phenolic varnishes give excellent water resistance, good electrical conductivity resistance, fair color retention, good weathering resistance and fair elasticity. Cumarone indene varnishes give the best property for leafing aluminum finishes. For finishes desired to give acid, alkali and water resistance, chlorinated rubber solutions should be considered, but in general they have poorer weathering resistance and poorer elasticity. Paints used in connection with lubricating oils and gasoline stocks are usually of vinyl vehicle, considered more in the plastic field. Oil base paints are generally used when good brushing, excellent elasticity and adhesion are required.

MULTI-CYLINDER GAS ENGINES

By John W. Tucker
Hall-Scott Motor Division

MULTI-CYLINDER engines of the automotive type, operating on gas or LPG, have been introduced in natural gasoline plants for supplying power for air compressors, jacket water pumps, high pressure lean oil pumps and other small or medium power requirements. Early experience showed certain changes in the installation were desirable, as compared with the use of the engine in automotive service. Jacket temperatures were brought up to around 170° F., to reduce condensation, sludging of the oil and corrosion. Special oil pans of larger capacity were developed. After experimenting with various types of crankcase oils, operators for the past few years have been using compounded, heavy-duty oils, which have been helpful in extending engine life, through less tendency to valve and ring sticking.

The following points should be taken into consideration when applying a multi-cylinder gas engine to the various power requirements of a natural gasoline plant or refinery:

1—Determine the hp. required for

present and possible future plant expansion or peak loads.

2—Determine the importance of the particular power requirement. What would happen if a power failure were to develop, or a normal shutdown for servicing. In almost all power applications in gasoline plants, 100% standby power should be provided. However, for jacket water pumps and cooling tower pumps, it is possible that 50% standby is considered ample, particularly if this is based on the maximum requirements under severe atmospheric conditions.

3—The size of the units in relation to the hp. and standby requirements, plus the initial cost of 3 medium sized units over 2 large units, has to be thoroughly studied. The higher the RPM at which an engine will operate satisfactorily, the lower the cost of an installation, especially if it will operate a given pump at a high enough speed to eliminate the necessity of a step-up gear. The most economical and practical installation is one that will give the greatest amount of service with the lowest investment and lowest maintenance cost.

In the early days it was accepted generally that, for maximum continuous load, the mean effective pressure should not exceed 50 to 60 lbs. at the RPM the load was to be applied. With the engine improvements which have been made it is generally conceded now that the selection can be based on a maximum 60 to 65 lbs. mean-effective pressure. Modern engines have been designed to operate satisfactorily in continuous service at higher RPM, and at higher piston speeds than 1000 ft.

With reference to the installation of automotive type engines, care should be taken to obtain full flow of the capacity of the water pump on the engine through the jackets. This can be accomplished by piping the full sized outlet of the jacketed waste to the inlet of the pump. The temperature can be maintained by injecting enough water to the inlet of the pump to hold the water temperature at the desired point. It is necessary to pipe the discharge water back into a line which automatically puts it back into the closed system of the plant. This discharge line should be at fairly low pressure, not to exceed 5 to 7 lbs. if possible.

The control on the inlet water to the suction side of the pump can either be done manually or by thermostat. The amount required will be determined first by the amount of the load and, second, the temperature of the jacket water that is available. The pressure on the inlet pipe will have to exceed the discharge pressure by about 10 lbs. or more, so that it can be injected into the system. With this design system the plant can utilize almost any temperature jacket water that happens to be available and yet maintain the desirable jacket temperature on the multi-cylinder engine at approximately 170° F.

MAINTENANCE of COOLING EQUIPMENT

By Harold Dresser
The Marley Co., Inc.

IN THE early days of the natural gasoline industry, data governing the selection of the cooling equipment was often inaccurate and, to be assured of proper operation, the equipment was greatly over-rated or over designed. Within the last few years, however, faced with ever increasing costs of labor and material, equipment manufacturers are designing and installing equipment which, instead of being 20 to 30% oversize, is from 1 to 2% oversize, sometimes not that much. As a result this equipment today must be properly operated and maintained to deliver a supply of cooling water sufficient for the plant needs.

Of first importance in the operation of any type of cooling tower is the proper distribution of the water. There are 3 general causes of improper distribution; (1) dirty or clogged nozzles or troughs, (2) too much water, (3) too little water. Clogged or dirty nozzles and troughs result from improper inspection, and weekly inspection of the distributing system is recommended.

Too much water being circulated causes water loss and often damage to nearby equipment from the excessive spray. With too little water being circulated the total area (horizontal) of the cooling tower cannot be properly covered with water. The recommended procedure for taking care of too much or too little water is for the plant operator to be informed of just how much the valves should be opened on the pump to assure circulation of the proper quantity.

Improper water distribution, no matter what the cause, will cause a marked change in the operation of the tower, that is, higher cold water temperatures will result. In towers with high final temperatures this will not mean very much but it will in towers where close approach to the wet bulb is desired.

Next in importance to the distributing system to obtain proper water cooling is the decking (wood fill) of a tower. In most cases semi-annual inspection of the decking is sufficient. Plants in areas of dust or sandstorms or near other manufacturing plants where dust is discharged need more frequent inspection. To keep the decks clean frequent washdown with a high pressure water hose is recommended. The water collecting basin should be inspected weekly, also the pit screen, and cleaned as often as required.

Water treatment is important to keep algae at a low point, and also to affect the life of the tower and the deposit of solids. Weekly tests of the water for Ph value should be made. Water with a Ph value above 7.5 with sodium carbonates or sodium bicarbonates present will immediately cause delignification of the wood. Under no circumstances should any water treatment be used which may leave an oily surface on the wood fill, which will increase the water loss and raise its temperature. The filling should be steam cleaned if leaks occur in the exchanger equipment and the tower becomes oily.

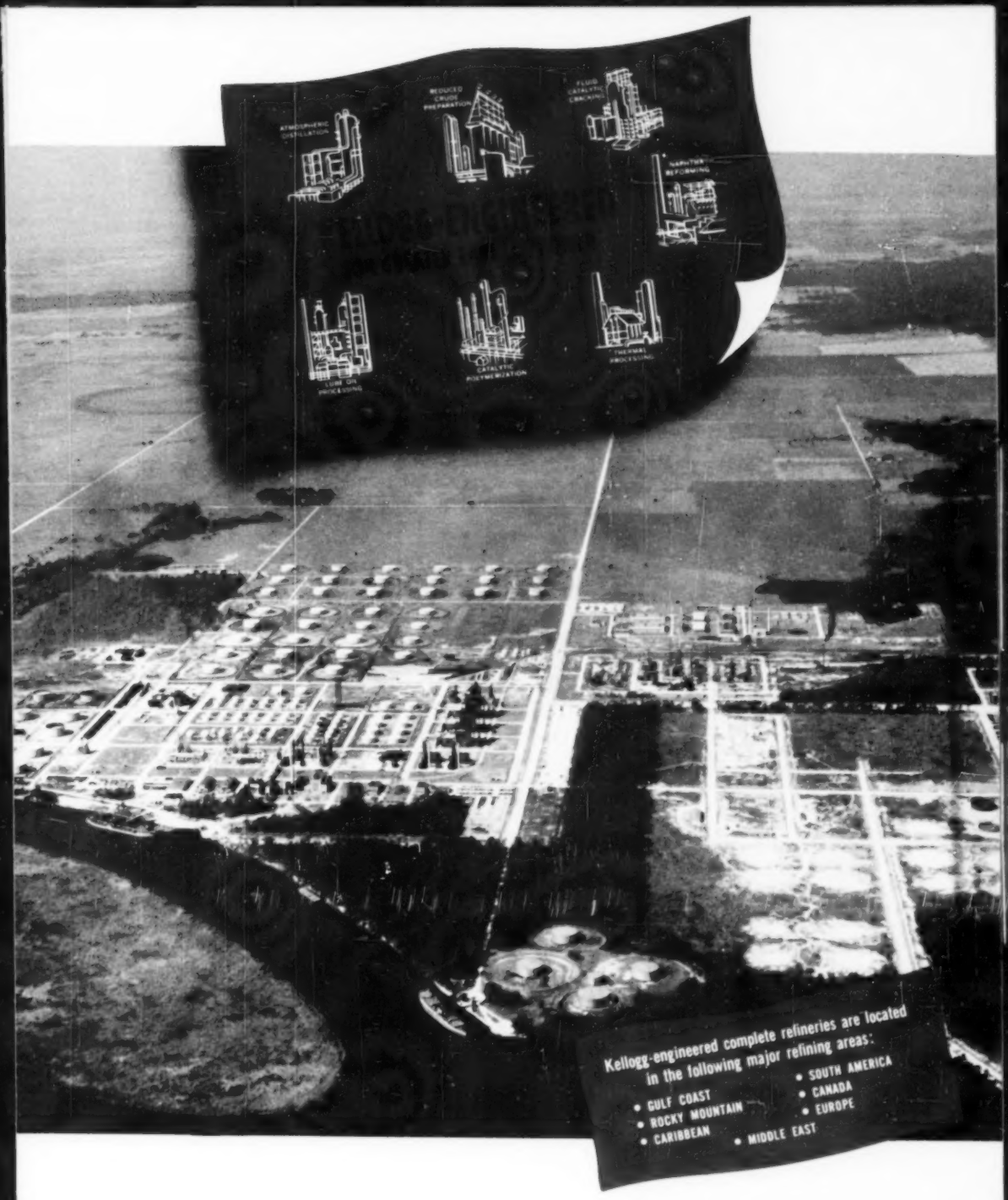
In mechanical draft towers and air cooled units, the proper operation of the mechanical equipment (electric motors, gas or diesel engines, gas or steam turbines, couplings, driveshafts, gear reducers and fans) is most important because this equipment has been selected by the manufacturer to meet the operating conditions for which the cooling unit was installed. There should be thorough regular inspection of the mechanical equipment.

The position of the mechanical equipment should not be changed once it has been installed. Misalignment as to elevation is necesary in some types of equipment.

Air cooled equipment in general needs the same maintenance as in mechanical draft towers, the reason being the same mechanical equipment is used. In small units V-belts and sheaves are used instead of gear units. In this type of drive, particular attention should be given to the correct tension of the V-belts, and the manufacturers' suggestions on maintenance should be followed. If one belt fails, a complete new matched set should be installed instead of replacing only the bad one.

Certain fouling factors are used in determining the proper operation and size of the cooling unit. An inspection after a week's operation, at rated capacity, should be made to determine if excessive fouling exists and, if so, the cause should be located and remedied. Generally speaking, higher temperatures and greater pressure drop through the unit indicate bad conditions exist. The finned surfaces of an air cooled unit can be cleaned by steam, compressed air, water, brushing and the use of chemicals.

If the final temperature of the material being circulated is higher than it should be, there is the possibility the wind is blowing in the wrong direction against the fans. Baffles or diverters can be installed to aid in this condition.



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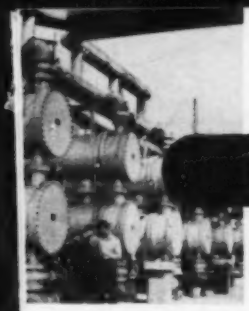


How to Control Leaks in Hand Holes In "Cat Cracker" Flue Gas Coolers

By E. G. WOOLMAN, Master Mechanic, Cities Service Oil Co., Lake Charles, La.

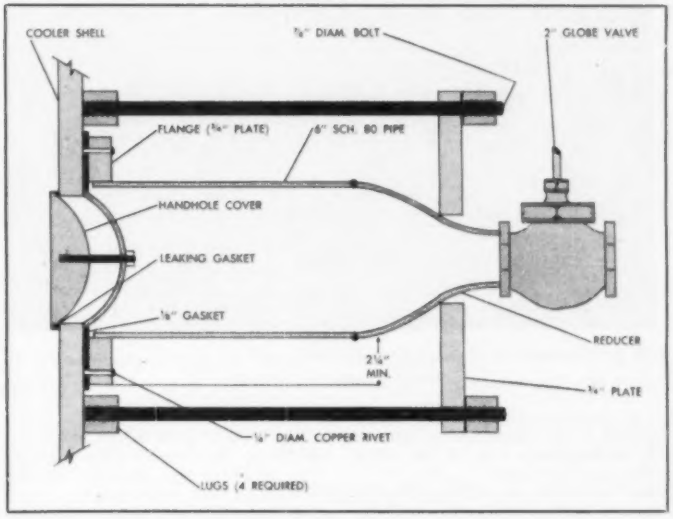


FIG. 1—Cross section of device for sealing off leaking hand hole covers on catalytic cracking unit flue gas coolers

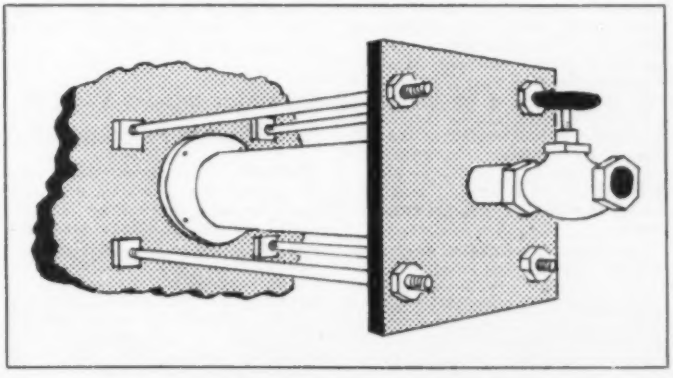


FIG. 2—Perspective view of the device illustrated in Fig. 1

LEAKING hand hole plates in the flue gas cooler of a catalytic cracking unit can become a serious problem. Should a flue gas cooler become ineffective because of a bad leak or a blown out hand hole gasket, serious damage would be done to the precipitators. In addition, stack loss of catalyst would be great and operating efficiency would be lowered by failure to utilize waste heat for steam generation.

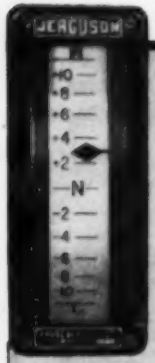
Such a situation involving a blown out gasket occurred in the Lake Charles refinery of Cities Service for the first time about three years ago. It was feared the unit might have to be shut down. The device shown in the drawings, Figs. 1 and 2 was designed and fabricated to overcome the problem. Similar devices have since been made and used since that time to avert possible shutdowns.

As shown in the drawings, the device consists of a length of 6-in., Schedule 80 pipe connected by a reducer to a 2-in. globe valve with a flange at the one end of the 6-in. pipe to fit around the outside of the leaking hand hole. This entire assembly is held to the flue gas cooler by four ⅞-in. bolts screwed into four lugs welded to the cooler shell and connected at their outer ends to a square ¾-in. "holder" plate. Leaking material thus is directed out through the globe valve until the assembly is firmly secured at which time the valve can be closed.

Referring again to Fig. 1, the four lugs are drilled and threaded and then welded to the shell around the hand hole. The flange for the 6-in. pipe must then be prepared by grinding and polishing for a close fit on the shell around the hand hole. The method recommended by the writer for insuring a close fit is as follows:

A location very near the hand hole is selected on the shell and the flange is ground to fit at this position. Then the surface area around the hand hole should be ground and polished before the apparatus is mounted. Before the apparatus is assembled as a complete unit, the flange should be placed over the first "test" area and checked for close fit.

Four ¼-in. copper rivets are then used to fasten a ⅛-in. gasket to the flange and to hold it in place when the apparatus is subjected to pressure. A good gasket cement should be used, both between flange and



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gasket and between shell and gasket, to insure a sealed joint.

The complete unit is then mounted, with the valve open. The valve must remain open after mounting, long enough for the gasket cement to set. This usually requires about a half-hour. When the cement is set, the valve may be closed slowly. Rapid closure should be avoided so that sudden pressure application will not break the seal.

Thermal Cracker Coil Release Valves Operated Remotely from Control Room

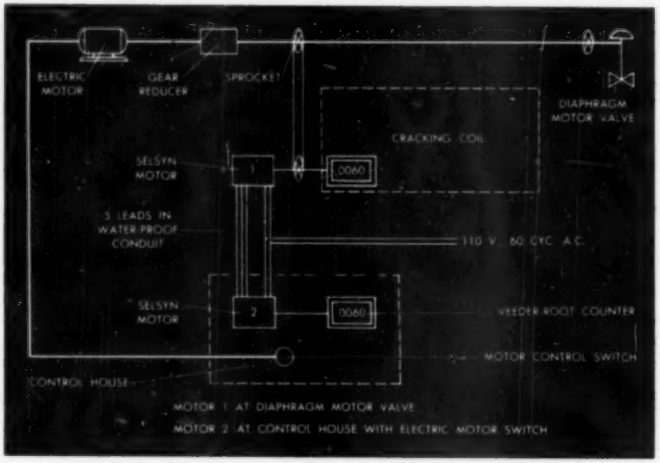

FIG. 3—Schematic arrangement of remote control set-up for release valves on thermal cracking unit coils

THE release valves on the thermal cracking unit coils at the Lima refinery of Standard Oil Co. (Ohio) normally are actuated by diaphragm motors. However, a hand wheel permits manual operation should the valves become stuck and inoperative by the motor.

In order to provide for safe and accurate actuation of these valves from a point in the thermal cracking unit control room, the instrument department worked out the arrangement illustrated in Fig. 3. The hand wheel is turned by a long drive shaft connected through a gear reducer to an electric motor located at the far side of the furnace. The system is set to revolve at 5 rpm. The motor is controlled by a simple "on-off-reverse" switch on the instrument panel.

To prevent overtravel of the valve through running the electric drive motor too far, a unique scheme has been adopted using a pair of selsyn motors (which, incidentally were picked up at very low cost) and a Veeder-Root counter. One selsyn is turned by a 1-1 ratio sprocket chain hook-up with the hand wheel drive shaft. The second selsyn turns the shaft of the Veeder-Root counter. The second selsyn and the counter are on the instrument panel.

It was found that about 60 revolutions of the hand wheel are needed to move the release valve the full range of stem travel from open to close. Therefore a small sign has been placed on the instrument panel alongside the counter, reading, "Closed—0; Open—60".

Jig Holds Impact Wrench In Awkward Position Jobs

IMPACT wrenches, especially those for the larger bolt sizes, are fairly heavy portable tools. They are particularly tough to handle when the bolt heads are in an awkward position; for example, bolt heads on the bottom heads of slurry bundles in the preheater of a Fluid catalytic cracking unit. On equipment of this type, there is normally no easy method for supporting the impact wrench so as to take a load off the operator.

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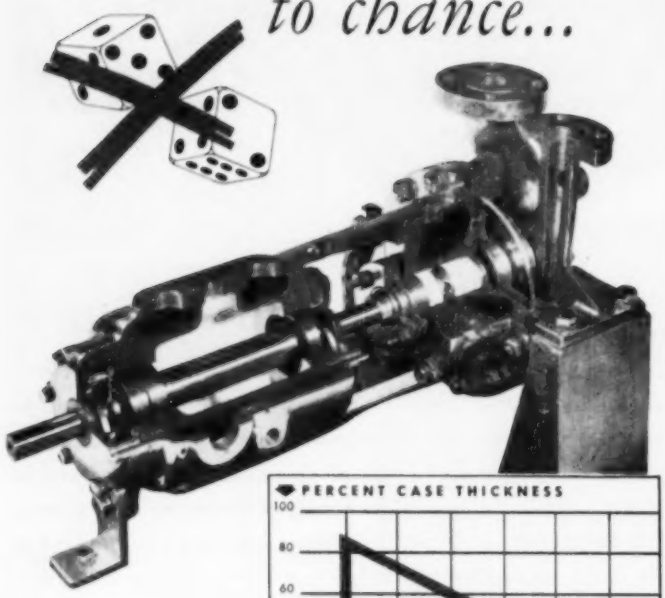

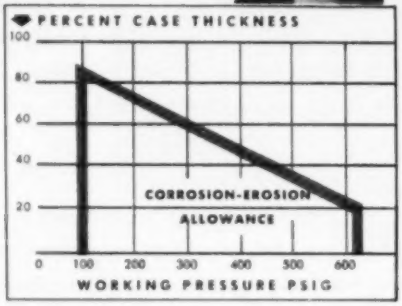

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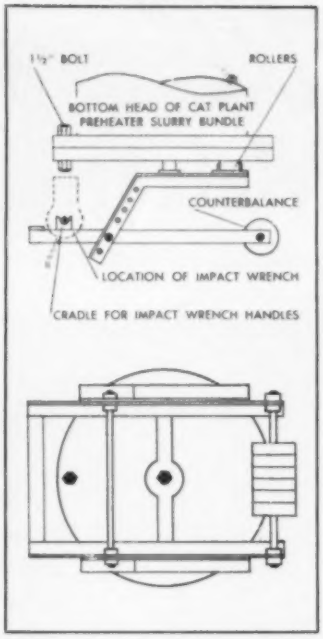

FIG. 4—Jobs using a heavy impact wrench are eased by this simple jig

Standard Oil Co.'s Baltimore refinery have devised a neat counterbalance cradle which is attached directly to the center bolt of the bottom head. This support for the impact tool is most easily described by referring to the sketch in Fig. 4. A series of perforations in the diagonal side strips of the cradle assembly, as well as removable counter weights, provide for considerable flexibility in handling the impact wrench.

Have You Any Ideas?

Plant superintendents, foremen, engineers, chemists, technicians—Send in your own ideas on "How we do it in our refinery," or "How we do things in our laboratory."

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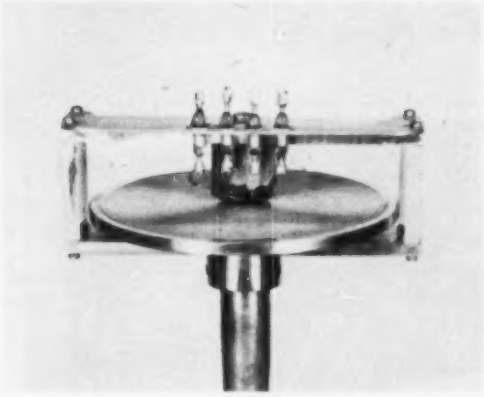
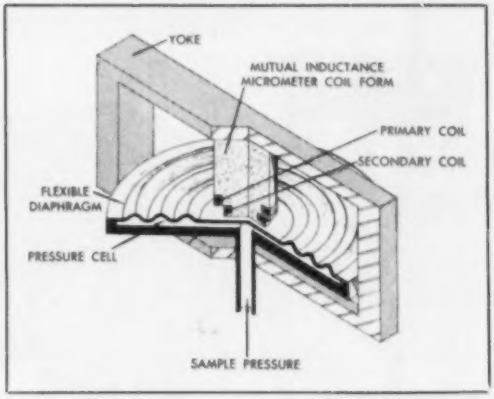




SENSITIVE HEART of the micromanometer is this pressure cell. Movement of the very thin diaphragm is measured by the electronic micrometer over it, but not in contact, and indicated on a calibrated microammeter (see cut-away at right)

Mass Spectrometer Analyses More Accurate With Sensitive Electronic Micromanometer

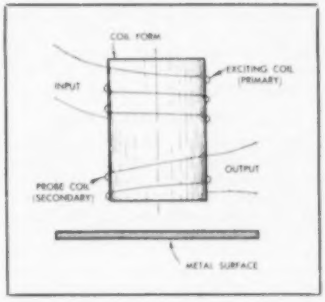
THE inevitability of error in the usual method of measuring gases for use in a mass spectrometer has resulted in the development of a new diaphragm-type micromanometer with an electronic pick-up to measure differential pressures in the micron region. Developed at the National Bureau of Standards, the new instrument is said to give rapid, direct readings on a microammeter scale that can be calibrated directly in units of pressure.

It is relatively insensitive to temperature changes, will operate in any position, and permits measurements that are totally independent of the type of gas or vapor being measured, according to Bureau engineers.

Errors in Usual Methods

The error encountered in the usual methods in connection with mass spectrometer work are explained as follows: A small sample is measured in an ordinary U-tube manometer and passed into the reservoirs of the machine, where it expands to 1000 times its original volume. Its pressure is then assumed to be 1/1000th of its original pressure. But this assumption fails to account for losses that occur through adsorption of the vapor by stop-cock grease and the walls of the system, and deviation from perfect gas laws.

It has been found desirable, therefore, to measure the pressure of the sample in the reservoirs after the losses have occurred. Manometers for the range from 0.001 to 0.1 mm. of Hg. usually are liquid-level devices, such as McLeod gages; or they depend on thermal effects, such as Pirani or thermocouple gages. McLeod gages are accurate, but the presence of mercury or oil vapor introduces difficulties into vacuum work; besides, these instruments are bulky and inconvenient to use. Pirani and thermocouple gages, while avoiding these difficulties, are inaccurate, and unless special care is exercised, give only a rough indication of the vacuum.



ELECTRONIC PICK-UP of the micromanometer is a mutual-inductance electronic micrometer. Current induced in secondary coil is proportional to distance from non-conducting metal surface—the pressure cell diaphragm

The Pressure Cell

The instrument developed at the Bureau comprises a pressure cell and an electronic micrometer, enclosed in a glass dome which can be evacuated or filled to any desired reference pressure. The pressure cell, the heart of the instrument, is composed of a very thin corrugated diaphragm sealed at the periphery to a slightly dished brass disk. This cell is connected to the gas sample so that change in pressure of the gas causes movement of the flexible diaphragm. Movement of the diaphragm in response to pressure variations is measured by a mutual-inductance micrometer placed over, but not in contact with, the diaphragm. Mechanical coupling errors are thus eliminated.

The micrometer was previously developed at the Bureau in connection with the design of indicating devices to measure clearances in journal bearings. (*NBS Technical News Bulletin* 31, 37, April, 1947). In principle, it makes use of the variation in mutual inductance between two concentric air-core coils which results when the distance of the coils from a nonmagnetic metal surface changes.

COMPLETE INSTRUMENT includes the micromanometer (in bell-jar) and a microammeter calibrated in pressure units for direct reading

When the metal is brought immediately adjacent to the end of the form supporting the coils, the mutual inductance is reduced to a minimum by what is effectively a "shielding" action of the metal. As the metal is moved away from the coils, the mutual inductance increases as a linear function of the separation.

In the micromanometer, the metal "shield" is the diaphragm of the pressure cell itself. Radio-frequency current is fed into a primary coil and induces a voltage in a secondary coil, mounted just above the diaphragm. The form supporting the coils is mounted rigidly with respect to the fixed portion (the brass disk) of the cell. Mutual inductance between coils is therefore a function of diaphragm expansion and hence is indicative of gas pressure.

This mutual inductance is compared to an adjustable reference value which is set in calibration for equality with zero differential in the cell. When pressure is applied, the balance is disturbed, and the resulting signal is proportional to gas pressure. This signal is amplified by suitable circuitry, is rectified, and finally appears as a d-c current through the microammeter on the panel of the instrument.

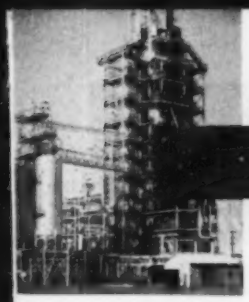
Alignment of coil form and diaphragm is not critical since, as a result of the linear response, all parts of the useful area of the diaphragm are weighted uniformly.

Only Two Calibration Points

Because of the linear relationship between pressure variation and electrical output, only two calibration points are required. In practice, the cell is first evacuated to the same pressure as that prevailing in the glass dome. Thus no differential pressure on the diaphragm exists, and the reference mutual inductance may be adjusted for zero reading on the meter scale. Slope, or scale-factor, adjustment is then made upon the introduction of an expanded gas sample of known pressure.

The manometer is capable of measuring pressures in the range of 1 to 100 microns with a sensitivity of about 0.1 micron on a 50 micron scale. Continuous use of the instrument for more than one year on one of the mass spectrometers at the National Bureau of Standards has shown that its sensitivity and zero point are remarkably constant. Frequent observations have disclosed variations in calibration of less than 1 micron over a 24-hour period. A differential pressure of one atmosphere applied externally on the pressure cell has only a slight hysteresis effect while pressures up to several tenths of a millimeter can be applied inside the pressure cell without harmful effects on the diaphragm.

Further technical details of the application of the micromanometer to the mass spectrometer will be given in a forth-coming article by V. H. Dibeler and F. Cordero in the *Journal of Research of the National Bureau of Standards*. Details of the design, operation and performance of the electronic equipment itself will be covered in a companion article by M. L. Greenough and W. E. Williams.



PROCESSING PATENTS

New Developments in Processes and Products

By PETER J. GAYLOR
Editor, "The Technical Survey"

Separation of Hydrocarbons By Selective Adsorbents

RECENTLY, interest has been exhibited by a number of oil companies, through their issued patents, in the selective adsorption of hydrocarbons as a means for separating the different classes from each other. For the most part, the adsorbents employed are the conventional ones, but the methods employed in attempting to reach a practical solution to the problem possess many novel features which could be discussed in greater detail.

We have already commented[1] on the Universal Oil Products Co. patent 2,395,491 employing silica gel for removing polynuclear aromatics, such as alpha methyl naphthalene, from mononuclear hydrocarbons, such as triethyl benzene, using a fixed bed system. Sun Oil Co. also did considerable work in recent years on silica adsorption as a means for separating polar hydrocarbons, such as aromatics, from paraffins, employing percolation followed by desorption of the aromatics by means of a solvent such as pentane. Some of this work was described in this column several years ago[2], in connection with U. S. 2,398,101. In its Patent 2,441,572, Sun Oil Co. describes a cyclic process involving treating the hydrocarbon mixture with silica gel, followed by washing out the adsorbed hydrocarbon with a desorbing agent of low absorption index, then washing with a secondary desorbing liquid to remove the primary desorber and reactivate the adsorbent for re-use.

Silicates, such as chabazite, have been proposed some time ago by Professor Barrer[3] as a means for "sieving" out branched chain from straight chain hydrocarbons. However, this mineral occurs only in limited amounts in nature, so that attempts have been made by Standard Oil Development Co. to produce synthetic adsorbents having similar properties. U. S. patent 2,442,191, issued to that firm, shows that some progress has been made in this direction, but the products obtained so far showed rather limited adsorption capacity, although selectivity was of a high order.

The use of charcoal as an adsorbent also has been investigated by Sun Oil Co., particularly for separating two aromatic hydrocarbons having the same number of double bonds per molecule and the same number of aromatic rings. In U. S. 2,518,236, it is pointed out that the type of adsorption isotherm encountered with binary mixtures may vary from that shown in Fig. 1 in which the two components have about the same absorbabilities when they are present in about equal proportions, to that shown in Fig. 2 in which one component is selectively adsorbable throughout substantially the whole concentration range. Figure 3 represents an intermediate type of behavior exhibited by some pairs of aromatics. The adsorption isotherms show the relationship between composition of the mixture at equilibrium with a given amount of adsorbent and the amount of component adsorbed.

In one example, a mixture of 97.8% ethylbenzene and 2.2% o-xylene was percolated through a small column containing activated carbon kept at 55°-60° F. The filtrate was analyzed and it was found that 46% contained 99.3% ethyl benzene, while an additional 22% had a purity of better than 98.7%. Since activated carbon is organophilic while silica gel is hydrophylic, the individual aromatics in some mixtures may be more strongly adsorbable on silica gel, while others are more adsorbable on carbon.

A Canadian Patent (468,057) to Imperial Chemical Industries discloses a process for recovery of ethylene from gaseous mixtures in which the gases are contacted with active carbon in a vessel throughout which the carbon moves unimpaired in a fluidized particulate state. Thereafter, the adsorbent is transferred to another vessel in which the ethylene is at least partially desorbed while the carbon is in the form of boiling bed having a state of agitation higher than in the adsorption stage. The ethylene is preferably removed with a hot inert vapor. Carbon of 180-250 micron particle size is specified.

A proposed method for selectively removing n-paraffins from admixtures with isoparaffins, naphthenes and aromatics is described in the Standard Oil Development Co. patent 2,522,426. The adsorbent employed is a mixture of hydrous oxides and hydroxides having a resulting empirical formula (based on the oxides) of $4\ CaO.Al_2O_3.4\ SiO_2$.

A fluidized technique is employed as shown in Figure 4. The hydrocarbon mixture enters contactor 1 through line 3 and passes upwardly through a grid 4 where it contacts adsorbent powder *B* which is maintained as a turbulent, dense, fluidized

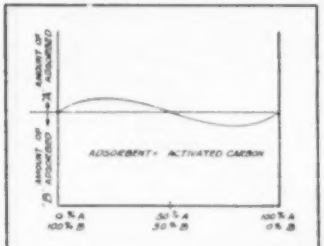


FIG. 1—Adsorption isotherm where components of about same absorbabilities are present in about equal proportions

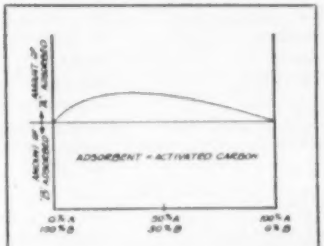


FIG. 2—Adsorption isotherm where one component is selectively adsorbable through substantially entire concentration range

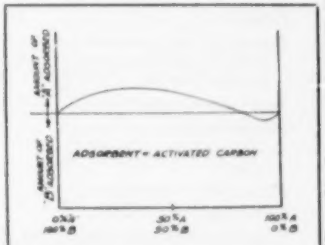


FIG. 3—Adsorption isotherm showing intermediate type of behavior exhibited by some pairs of aromatics

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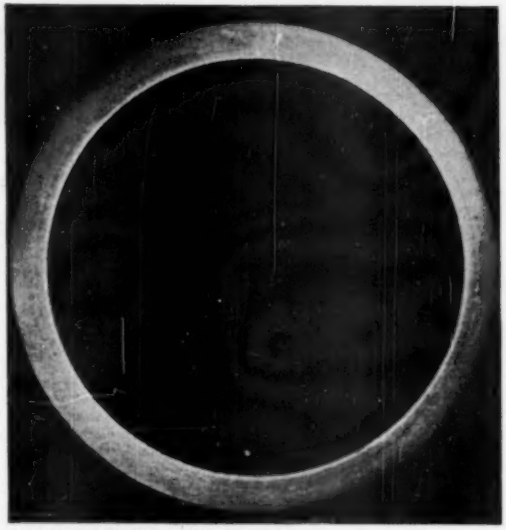

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- Furfural condensers and exchangers
- MEK service
- Propane chilling
- Wax sweaters
- Depropanizer overhead condensers

Chemical

- Butanol
- Ethanol
- Ethylene Glycol
- Glycerin
- Hydroabietyl
- Isopropanol
- Methanol
- Phenol
- Propylene Glycol
- Acetaldehyde
- Formaldehyde
- Acetic Acid
- Butyric Acid
- Stearic, Palmitic, Oleic Acids
- Recinoleic Acid
- Acetanilide
- Ammonia and Ammonium Hydroxide
- Hydrogen Cyanide
- Nitric Acid (concentrated)
- Pyridine
- Hydrogen Sulfide
- Benzene
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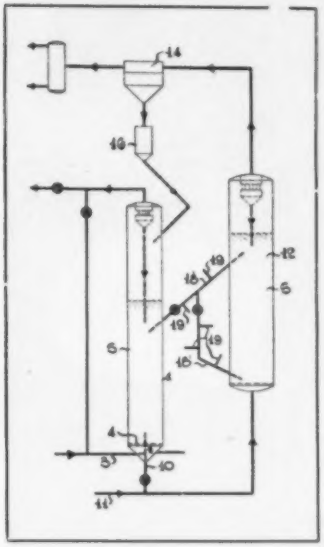

FIG. 4—Fluidized process for selectively removing n-paraffins from admixtures with isoparaffins, naphthenes, and aromatics

mass by controlling the upward velocity of the gases within the range of 0.5-5 ft. per sec. Adsorbent *S* adsorbs the straight chain paraffins and is withdrawn through line 10 at which point it meets the stripping gas fed in through line 11. The mixture is then led to stripper 12 in which desorption of the n-paraffins takes place. Cyclones 14, 16, and other equipment conventional with fluidized systems, are likewise employed. The stripped adsorbent is returned from stripper 12 to contactor 1 by line 18, and taps 19 are provided for addition of fluidizing gas.

The method just described has been proposed as a means for separating hydrogen from gaseous mixtures in Standard Oil Development Company's patent 2,526,524. Steam is used to displace the hydrogen from the adsorbent.

Another fluidized solids means for fractionating gases with powdered adsorbent is described in Standard Oil Development Company's patent 2,523,149. In this case, the process involves concentrating an intermediate component B from a vaporous mixture also containing a less readily adsorbed component A and a more readily adsorbed component C.

A very recent patent, U. S. 2,527,-964, issued to Phillips Petroleum Co. also discloses a recycle system for separating gaseous mixtures into two fractions by means of a finely divided adsorbent. In this case, the stripped adsorbent is suspended in a cooled recycle stream to cool the adsorbent.

Considerable work appears to be in progress in the adsorption separation field, and there is a likelihood that commercialization of one of the processes may be undertaken in the near future.

References

(1) Gaylor, Petr. Proc. 5/47 p.380.
(2) Gaylor, Petr. Proc. 10/47 p.780.
(3) Gaylor, Petr. Proc. 8/48 p.787.

Patents Issued in October

The following classified listing gives the patent number, patentee or assignee, and a brief description of all patents believed to be of interest direct to the petroleum processing industries, as contained in the Official Gazettes of the U. S. Patent Office for Oct. 3, 10, 17, 24 and 31, Vol. 639, Nos. 1-5.

Fuels

2,524,864 (Shell Development Co.)—Non-clogging fuel oil containing glycerolphthalate anhydride resin and Ba alkyl phenol sulfide.
2,526,499 (Standard Oil Development Co.)—

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Removing peroxides from gas oil.
2,527,889 (Union Oil Co. of Calif.)—Diesel engine fuel containing ester and corrosion inhibitor.
2,527,987 (Shell Development Co.)—Anti-clogging concentrate for fuel oils.

Conversions

2,524,566 (Shell Development Co.)—Copper-magnesia hydrogenation catalyst.
2,525,276 (Hercules Powder Co.)—Cracking hydrocarbons with injected gas.
2,525,787 (Socony-Vacuum Oil Co.)—Propylene polymerization.
2,525,811 (Standard Oil Co.—Ind.)—HF conversion of hydrocarbons.
2,525,812 (Standard Oil Co.—Ind.)—Combination HF-treating-catalytic cracking process.
2,525,814 (Pan American Refining Corp.)—Catalytic conversion of hydrocarbons with refractory oxide followed by HF.
2,526,068 (Universal Oil Products Co.)—Catalytic cracking of hydrocarbons, using multiple reactors.
2,526,486 (Standard Oil Development Co.)—Handling pulverulent catalyst in hydrocarbon conversion and catalyst regeneration.
2,526,625 (Houdry Process Corp.)—Cracking in presence of moving catalyst bed.
2,526,657 (Phillips Petroleum Co.)—Contacting vapors with solid catalyst.
2,526,696 (Lummus Co.)—Simultaneous production of coke and gaseous unsaturated hydrocarbons.
2,526,700 (Houdry Process Corp.)—Hydrocarbon conversion in presence of steamstable catalyst.
2,526,881 (Shell Development Co.)—Catalytic conversion of hydrocarbons to produce alkyl naphthalenes.
2,526,966 (Phillips Petroleum Co.)—Treating and transporting hydrocarbons.
2,527,198 (Standard Oil Development Co.)—Gasifying carbonaceous material.
2,527,522 (Houdry Process Corp.)—Selectively polymerizing isobutylene.
2,527,529 (Phillips Petroleum Co.)—Conversion of polyalkyl aromatics to monoalkyl aromatics.
2,527,573 (Pan American Refining Corp.)—Cracking with HF catalyst.
2,527,768 (Phillips Petroleum Corp.)—Polymerization of unsaturated materials with alkali metal catalyst.
2,527,794 (Socony-Vacuum Oil Co.)—Fluoroboric alkylation of thiophene.

Refining

2,525,152 (Standard Oil Development Co.)—Stabilizing cracked gasoline containing aromatic mercaptans.
2,525,583 (Pure Oil Co.)—Removing mercaptans from caustic by oxidation in presence of wood tar.
2,525,812 (Standard Oil Co.—Ind.)—Combination HF-treating-catalytic cracking process.
2,525,813 (Standard Oil Co.—Ind.)—Distillate fuel manufacture involving extraction with liquid HF.
2,526,962 (Phillips Petroleum Co.)—Inhibiting formation of odoriferous compounds in normally saturated hydrocarbon by distilling in presence of added H_2S.
2,526,971 (Phillips Petroleum Co.)—Separating olefins from mixtures with cuprous salt of o-anisidine.
2,527,176 (Standard Oil Development Co.)—Treating oils with fuming acid, chlorite and clay to prevent corrosion to copper.
2,527,404 (Phillips Petroleum Co.)—Propane fractionation of lube oil stocks.
2,527,833 (Atlantic Refining Co.)—Regenerating spent aqueous alcoholic caustic solutions containing mercaptides.
2,527,951 (Phillips Petroleum Co.)—Hydrocarbon separation with ethanol-amines.
2,527,964 (Phillips Petroleum Co.)—Separation of gaseous mixtures with adsorbents.
2,528,028 (Barry)—Separating hydrocarbon liquids and water from high-pressure gas streams.
2,528,032 (Candler et al)—Treating petroleum emulsions.
2,528,363 (Phillips Petroleum Co.)—Treating cat. cracked gasoline.
2,528,426 (Lummus Co.)—Solvent extraction apparatus.

Chemicals

2,524,084 (Shell Development Co.)—Peroxidic sulfonic acids and salts.
2,524,086 (Universal Oil Products Co.)—Polycyclicalkyl arylsulfonic acid derivatives as surface-active agents.
2,524,315 (Socony-Vacuum Oil Co.)—Ammonium sulfate production.
2,524,777-8 (Cities Service Research & Development Co.)—Butadiene - methylal addition products.
2,525,061 (Standard Oil Development Co.)—Accelerated polymer curing method.
2,525,343 (Great Lakes Carbon Corp.)—Activated carbonaceous compounds by reacting sulfocarbon with sulfur vapors.
2,525,354 (Shell Development Co.)—Catalytic refining of hydrocarbon alcohols.
2,525,773 (Socony-Vacuum Oil Co.)—Chlorine addition product of thiophene.
2,525,774 (Socony-Vacuum Oil Co.)—Heptachlorothiolane.
2,525,809 (Standard Oil Co.—Ind.)—Intermolecular condensation of HF-insoluble linear fused-ring polycyclic aromatic hydrocarbons.
2,525,810 (Standard Oil Co.—Ind.)—Intermolecular chemical condensation of an alkyl naphthalene.
2,525,818 (Phillips Petroleum Co.)—Nitriles from aldehydes and ammonia.
2,525,889 (Phillips Petroleum Co.)—Higher fatty acids by reacting isoparaffins with unsaturated acids.
2,526,504 (Standard Oil Development Co.)—Increasing bruise resistance of low-unsaturation isobutylene-diolefin rubber.
2,526,508 (Standard Oil Development Co.)—Recovery of fatty acids from dilute aqueous solutions.
2,526,509 (Sun Oil Co.)—Photoelectric recording system (spectrometer).
2,526,854 (Jasco, Inc.)—Modified styrene interpolymers.
2,526,689 (Standard Oil Development Co.)—Controlled catalytic oxidation.
2,526,702 (Shell Development Co.)—Lactones.
2,526,894 (Universal Oil Products Co.)—Condensation of thiophenes with ketones.
2,526,895 (Universal Oil Products Co.)—Polycyclic aromatic hydrocarbons.
2,526,896 (Universal Oil Products Co.)—Diaryl alkanes.
2,526,897 (Universal Oil Products Co.)—Aryl indanes by hydrogen transfer.
2,526,899 (Pan American Refining Corp.)—Methyl benzenes, using HF catalyst.
2,527,017 (Shell Development Co.)—Purification of secondary lower alkyl amines.
2,527,121-2 (Standard Oil Development Co.)—Determining olefins in hydrocarbon mixtures.
2,527,162 (Standard Oil Development Co.)—Interpolymers of a styrene, acrylonitrile and diolefins.
2,527,335 (Socony-Vacuum Oil Co.)—Alkyl dibenzothiophene sulfonic acid.
2,527,824-5 (California Research Corp.)—Xylene isomers.
2,527,948 (Phillips Petroleum Co.)—Dialkyl polysulfides.
2,528,262 (Petrocarbon, Ltd.)—Recovery of mono-chlorhydrins from aqueous solutions.
2,528,306 (Socony-Vacuum Oil Co.)—Thenylamines.
2,528,417 (Shell Development Co.)—Epoxy ether composition.
2,528,469 (Shell Development Co.)—Granular polymerization of vinyl chloride.

Lubricants

2,524,563 (Shell Development Co.)—Lubricant (grease) containing polymerized ester.
2,525,076 (Standard Oil Development Co.)—Pour depressants.
2,525,788 (Socony-Vacuum Oil Co.)—Mineral oil lubricants containing polymers of 1-olefins.
2,526,041 (Sharples Chemicals, Inc.)—Hydrocarbon oil lubricant containing ditert.-alkyl sulfides.
2,526,490 (Standard Oil Development Co.)—Pour inhibited oil.
2,526,497 (Standard Oil Development Co.)—Mineral lubricating oil containing poly-sulfides of thiophosphorous (ic) esters.
2,526,506 (Standard Oil Development Co.)—Hydrocarbon lubricant containing sulfurized aliphatic borates as stabilizers.
2,526,755 (The Texas Co.)—Turbine oil inhibited with 2-hydroxy-3-tert. butyl 5-methyl benzyl tert. alkyl sulfide.
2,526,931 (Phillips Petroleum Co.)—Improving

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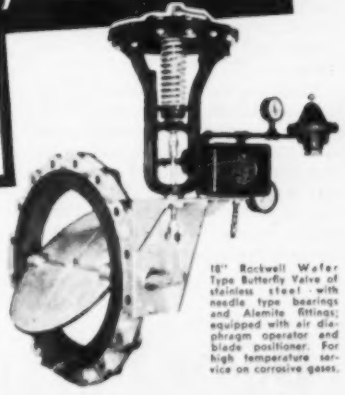

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[To obtain more data on advertised products see page 1356]

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Processing Patents

color and VI of lube oils by treating with HF and molybdenum sulfide.
2,527,279 (Gulf Oil Corp.)—Di(alkylphenol) sulfide anti-oxidants for lubricants.
2,527,334 (Socony-Vacuum Oil Co.)—Lube oil containing salts of alkylated dibenzothiophene sulfonic acid.
2,527,789 (Shell Development Co.) — Cooling greases.
2,528,092 (Gulf Oil Corp.)—Anti-oxidants for mineral oil compositions.
2,528,257 (Union Oil Co. of Calif.)—Lube oil containing additives.
2,528,346 (California Research Corp.)—Lubricant containing dialkyl selenides.
2,528,373 (The Texas Co.)—Alkenyl succinic acid grease.
2,528,465-6 (California Research Corp.)—Foam inhibited lube oil containing phenates, etc.

Hydrocarbon Synthesis

2,525,086 (Standard Oil Development Co.) — Hydrocarbon and oxygenated organic compound synthesis using modified Fe catalyst.
2,525,827 (Hydrocarbon Research, Inc.)—Hydrocarbons by reduction of CO and hydrogen.
2,526,521 (Standard Oil Development Co.)—Gas mixtures containing CO and hydrogen.
2,526,524 (Standard Oil Development Co.)—Separating hydrogen from hydrogen containing gases.
2,526,651 (Hydrocarbon Research, Inc.)—Separating powdered catalysts from exothermically reactive gases.
2,526,652 (Hydrocarbon Research, Inc.)—Synthesis gas manufacture.
2,526,934 (Phillips Petroleum Co.)—Removing heat of reaction from synthesis mixture.
2,527,130 (Standard Oil Development Co.)—Hydrocarbon synthesis and catalyst.
2,527,154 (Standard Oil Development Co.)—Increasing heating value of synthesis tail gas.
2,527,197 (Standard Oil Development Co.)—Carbon monoxide and hydrogen gases from carbonaceous material.
2,527,846 (Stanolind Oil & Gas Co.)—Hydrogen-carbon monoxide synthesis.

Specialties

2,524,309 (American Marietta Co.)—Lube oil, etc. as antifoamer for proteinaceous solutions.
2,524,315 (Phillips Petroleum Co.)—Adhesive composition for air filters.
2,524,357 (Socony-Vacuum Oil Co.)—Heat-resistant paint.
2,524,484 (The Texas Co.)—Antifreeze liquid (inhibited).
2,524,825 and 2,525,078 (Socony-Vacuum Oil Co.)—Metal cleaning composition.
2,526,120 (Phillips Petroleum Co.)—Pelleting carbon black.
2,526,655 (Jasco, Inc.)—Wax-resin compositions.
2,526,948 (Phillips Petroleum Co.)—Treating textiles with half-acid amide derivatives.
2,527,296 (Tide Water Associated Oil Co.)—Rust preventive compositions.
2,528,347-8 (California Research Corp.)—Nonflammable hydraulic fluid.

Catalysts

2,524,358 (Socony-Vacuum Oil Co.)—Colloidal silica solutions.
2,524,809 (Standard Oil Development Co.)—Hydrogel catalyst containing Al, Cr or Fe.
2,524,810 (Standard Oil Development Co.)—Hydrogel catalyst containing Ti, Zr, Sn or Th.
2,525,135 (Universal Oil Products Co.)—Forming pills or pelleted particles.
2,525,144 (Universal Oil Products Co.)—Improved solid phosphoric acid catalyst.
2,525,145 (Universal Oil Products Co.)—Supported phosphoric acid-boric acid catalyst.
2,525,830 and 2,526,564 (Phillips Petroleum Co.)—Recovery of anhyd. $AlCl_3$ from fluid aluminum chloride-hydrocarbon complex.
2,526,701 (Houdry Process Corp.)—Hydrating catalyst with steam in catalytic conversion.
2,526,907 (Universal Oil Products Co.)—CO-precipitation of silica-alumina.

Miscellaneous

2,525,072 (Standard Oil Development Co.)—Chewing gum containing silica and alumina treated with methyl chlorsilanes.
2,525,821 (Phillips Petroleum Co.)—Insulation of thermal vessels (internal).
2,526,463 (Standard Oil Development Co.)—Vessel for handling corrosive fluids.
2,527,170 (Standard Oil Development Co.)—Apparatus for detecting corrosion.

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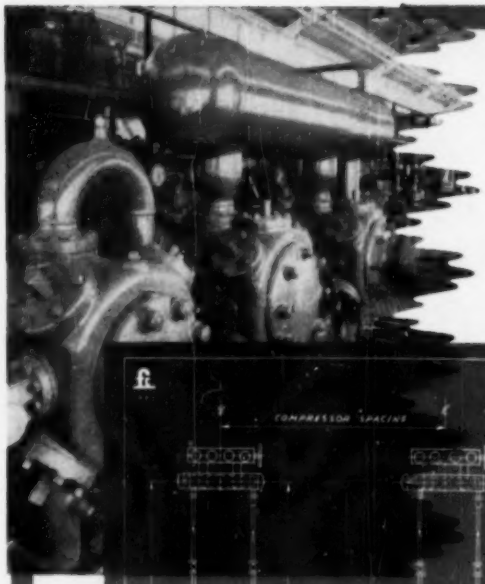
Ortho-dichlorobenzene • Monochlorobenzene • Methanol • Ammonium Chloride • Formaldehyde



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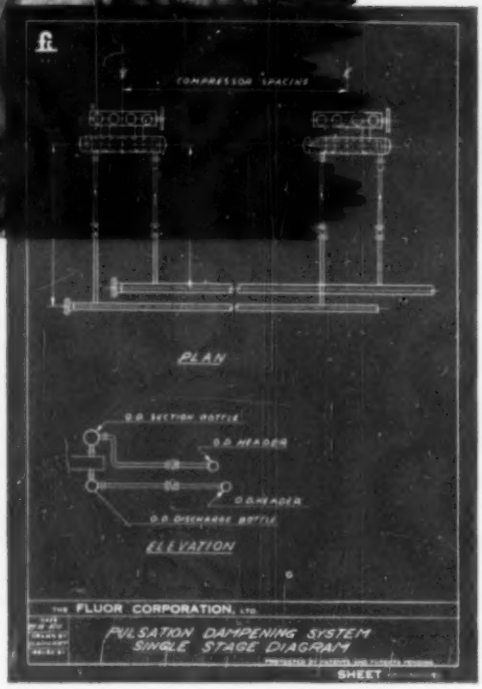

A 4-page Bulletin giving detailed information on this "pulse-free" piping system is available upon request.

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Fluor Pulsation Dampening Piping Systems are *guaranteed* to provide a steady, smooth gas flow with minimum pressure drop. Because of this steady flow, many advantages are realized by the operator. Safety is increased by eliminating vibrational stress on piping, heat exchanger and vessels. Compressor operating efficiency is increased, metering inaccuracies caused by pulsative flow are reduced, and maintenance problems common to conventional piping systems are cut to a minimum.

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Fluor Pulsation Dampening Piping Systems are designed primarily for new construction. Furnished in prefabricated form, the system is comparable in first costs with conventional piping systems. More important, though, are the savings possible in being able to design and specify related equipment based on a system *free* of pulsative flow and its attendant problems.

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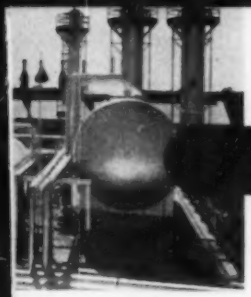

Novel Catalyst Form Improves Reaction Temperature Control

SOLID catalyst in the form of sheets, screens, grids, etc., instead of the conventional granules is claimed to improve temperature and reaction control in catalytic units of the stationary bed type, as employed in such hydrocarbon conversions as cracking, reforming, dehydrogenation, hydrogenation, polymerization and the like.

One form of the catalyst material is illustrated in Fig. 1, isometrically and inserted in the catalyst tube 10 of the process vessel. It comprises a folded screen 11 coated with catalyst. The screen 11 is held in proper shape by metal supports 12 consisting of crossbars in the form of a simple Greek cross. Additional supports may be used between the ends of such an assembly. A longitudinal support bar may also be included to provide rigidity in the screens.

Screen 11 is of fine mesh wire. The coating completely fills and covers the meshes or it may cover only the individual wires, maintaining the open mesh, to allow better flow of reactants. Screen and supports are preferably constructed of heat and oxidation resistant alloys. They may or may not possess catalytic properties.

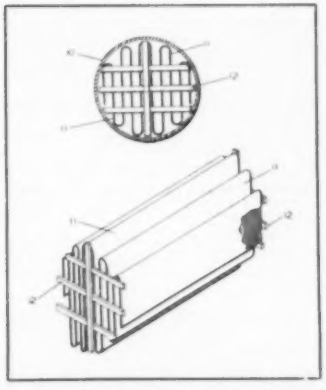

FIG. 1—One style of a unique catalyst form to improve temperature control in catalytic reactors (U. S. 2,526,657)

The catalyst member may be any of several compressed forms which can be inserted into the tube. It can be folded as is screen 11, or it can be a coiled volute or flat spring plate or screen, or a wire shaped into a helical spring.

Chief advantage for the new shape over granular catalyst is in better heat control. The amount of unfilled space in the catalyst tube permits better circulation of reactants with increased rate of heat tranfer and consequently better control of optimum conversion temperatures. At the same time, sufficient catalyst is present in the metal screen coating to insure satisfactory contact area.

With endothermic reactions, it is said this catalyst arrangement avoids the necessity of preheating the charge to higher than reaction temperature. In addition, catalyst in this form provides for low pressure drop because there is less resistance to reactants flow. Finally, catalyst is easily removed and replaced when it has deteriorated to the point where it can be satisfactorily regenerated. It is moved out of the tube as a unit. There is no fusion of small particles to the tube walls.

U. S. 2,526,657, issued October 24, 1950, to Jesse A. Guyer, assignor to Phillips Petroleum Co., Bartlesville, Okla.

Catalyst Feed Device Reduces Abrasive Wear on Particles

A CATALYST feeder for moving bed cracking units utilizing a mechanism of the "star feeder" type is said to protect catalyst granules from breakage or erosion and also form an efficient gas seal of less overall height than is normally required by a long sealing leg.

As shown in the cross section in Fig. 2, the feeder is located between the hopper and the reaction vessel 17. Blades 4 are rotated through reduction gearing by an electric motor, not shown. In the chute 26, there is a "chopper" valve 32 which can be manually or otherwise adjusted to any desired position. Baffle 35 blocks the flow of catalyst over the top of the chopper valve. By means of this valve the thickness of the catalyst stream in chute 26 can be regulated. Vent nozzle 36 may be discharged to the atmosphere.

In operation, the compartments of the rotor are brought successively into register with inlet port 10 by clockwise rotation of the rotor. Owing to the location of port 10, no compartment will receive entering ma-

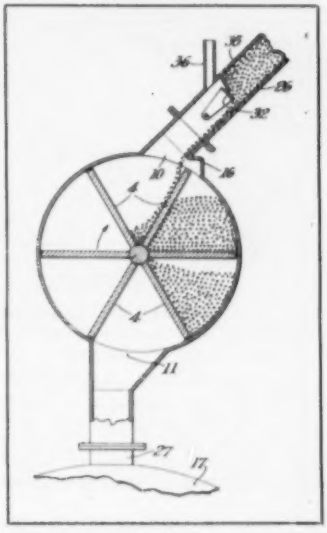

FIG. 2—Star feeder for transfering catalyst to reactor in a moving bed cracking unit (U. S. 2,524,572)

terial until the advance blade of the compartment has passed the port. Then the stream of material flows so a gentle delivery is obtained and abrasion is minimized. Speed of rotation is so arranged to prevent complete filling of the compartments, avoiding pinching or crushing of catalyst particles. The material is merely lowered until a blade reaches discharge port 11. Then it flows by gravity into the reactor 17.

Offset 16 at the inlet port 10 avoids pinching granules between the blades of the rotor and the outer wall of the casing. Another safeguard against

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Equipment Patents

pinching is the closeness of the rest of the casing to the edges of the rotor blades, thus precluding entry of material between blades and walls.

U. S. 2,524,572, issued October 3, 1950, to Ralph H. Riemenschneider, assignor to the Lummus Co., New York.

Patents Issued in October

The following classified listing covers patents issued during the month of October believed to be of interest or value to petroleum processing or handling operations.

Catalytic Reactors

2,524,572 (Lummus Co.)—Catalyst feeding device.
2,526,657 (Phillips Petroleum Co.)—Form of catalyst construction for fixed bed unit for improving temperature and reaction control.
2,526,715 (Western Precipitation Corp.) — Equipment for introducing air to insulated electrode structures in electrical precipitators.
2,527,198 (Standard Oil Development Co.) — Apparatus for gasifying carbonaceous solids in the water-gas reaction.

Processing, general

2,524,397 (Elliott Co.)—Gas separation apparatus, particularly for obtaining sulfur dioxide from waste furnace gases in liquid form.
2,524,398 (M. W. Kellogg Co.)—Centrifugal separator utilizing two vortexes having opposite rotation.
2,524,635 (Permutit Co.)—Equipment for treating aqueous solutions of electrolytes by ion exchange materials.
2,525,064 (Standard Oil Development Co.) — Multiple bell cap clamp.
2,525,218 (Glitsch Engineering Co.)—Bubble cap assembly.
2,525,842 (The Dorr Co.)—Liquid clarifier using flocculation and sedimentation.
2,526,478 (Worthington Pump & Machinery Corp.)—Cold process water softener.
2,526,996 (Elliott Co.)—Apparatus for separating mixed gases, particularly for recovering high purity oxygen from air.
2,527,789 (Shell Development Co.)—Apparatus and process for quickly cooling lubricants and especially lubricating greases.
2,528,099 (The Dorr Co.)—Equipment and method for conducting ion exchange operations.
2,528,426 (Lummus Co.)—Solvent extraction apparatus.

Instruments

2,524,241 (Hagan Corp.)—Apparatus for measuring the product of two or more variables.
2,524,343 (M. W. Kellogg Co.)—Mechanism for controlling valves, particularly slide valves for fluid catalyst lines.
2,524,445 (Joseph Lucas Ltd., Birmingham, England)—Means for controlling the temperature of hot gases, for example those from the combustion chambers of furnaces, gas turbines, and jet engines.
2,524,478 (Bailey Meter Co.)—Bolometer of wide sensitivity.
2,524,602 (Republic Flow Meters Co.)—Force measuring apparatus.
2,525,077 (Radio Corp. of America)—Electronic computer.
2,525,124 (Universal Oil Products Co.)—Electrical computer.
2,525,197 (U.S.A. as represented by the U.S. Atomic Energy Commission)—Thermal flow meter.
2,525,754 (Hall Laboratories, Inc.)—Conductivity cell for measuring the concentration of a salt or chemical in a liquid.
2,525,851 (Harry D. Ayars)—Air supply control for can filling machines.
2,525,873 (Sperry Products, Inc.)—Lens system for ultrasonic viewing of defects in objects.
2,525,914 (Flowmeter Corp.)—Stroboscopic flow indicator for fluids.
2,525,991 (Stoppani A.-G., Berne, Switzerland) —Flow meter of the positive displacement type.
2,526,192 (Union Oil of California)—Crude oil storage tank gage.

2,526,337 (Harry W. Dietert Co.)—Volumetric gas analysis apparatus.
2,526,509 (Sun Oil Co.)—Photoelectric recording system, particularly for the recording of Raman spectra.

Furnaces and Heaters

2,524,795 (Babcock & Wilcox Co.)—Furnace lighter tube construction.
2,527,410 (Selas Corp. of America)—Heater for fluids.

Pumps and Compressors

2,524,770 (F. E. Myers & Bro. Co.)—Centrifugal ejector pump.
2,525,265 (Robbins & Myers, Inc.)—Glandless, helical screw type pump.
2,525,365-6 (Rotary Seal Co.)—Shaft seal.
2,526,590 (E. J. Sullivan and D. A. Ostrander)—Mechanical shaft seal.
2,526,594 (Westinghouse Electric Corp.)—Seal and bearing for rotary shafts of gas compressors.
2,526,751 (Ingersoll-Rand Co.)—Mounting device for pump impellers.
2,526,830 (H-P-M Development Corp.)—Variable delivery gear pump.
2,527,088 (Mission Mfg. Co.)—Gland packing for rotary shafts.
2,527,670 and 2,527,673 (Robbins & Myers, Inc.)—Helical pumps.
2,527,971 (Edward A. Stalker)—Axial-flow compressor.

Tanks and Vessels

2,525,217 (Glitsch Engineering Co.)—Manway clamp.
2,525,758 (Chicago Bridge & Iron Co.)—Floating roof type gas holder for storing gases under pressure.
2,525,821 (Phillips Petroleum Co.)—Thermal insulation method for vessels used in thermal conversion processes.
2,526,463 (Standard Oil Development Co.)—Vessel for handling corrosive fluids, for example, weak sulfuric acid and acid sludges.

Tools

2,524,608 (Nils H. Christenson)—Attachment unit for acetylene torches.
2,524,164 (Frank E. Dudley and Harry K. Dudley)—Tube expander.
2,524,223 (Fred J. Giroux)—Arc oxygen cutting accessory.
2,524,376 (Marion A. Clark)—Sliding side jaw wrench with toggle means for moving and locking the movable jaw relative to the fixed jaw.
2,524,489 (August A. Westman)—Self-locking wrench.
2,525,630 (B.M.C. Mfg. Corp.)—Toggle-actuated plier-type wrench.
2,526,167 (John M. Henry)—Slidable jaw pipe wrench.
2,526,471 (Samuel Ginns)—Pipe cutter.
2,526,472 (Blackwell & Sutde, Inc.)—Pipe testing plug.

Valves and Fittings

2,524,104 (Clifford P. Graham)—Plug valve.
2,524,129 (Lincoln Engrg. Co.)—Check valve.
2,524,446 (Bailey Meter Co.)—Control valve and pressure responsive actuator.
2,525,807 (Specialties Development Corp.)—Vapor trap for the discharge of liquid level indicator line of a liquefied gas storage vessel.
2,525,826 (Blaw-Knox Co.)—Reversing valve for controlling admission of air to one end of a reversing furnace and outflow of combustion gases from the other end.
2,525,831 (Rockwell Mfg. Co.)—Coated lubricated plug valve.
2,525,928 (Fred W. McRae)—Valve for oxygen and acetylene tanks used for oxy-acetylene welding.
2,525,989 (Cameron Iron Works)—Seal for a gate valve closure member.
2,526,019 (W. D. Fowler)—Relief valve for oil storage tanks.
2,526,346 (R. G. Goldinger)—Accident valve to seal off a line in case of damage or breakage.
2,526,794 (E. I. du Pont de Nemours & Co.)—Frangible diaphragm safety device for pressure vessels.
2,526,795 (E. I. du Pont de Nemours & Co.)—Safety relief diaphragm.
2,527,050 (Cameron Iron Works)—Gate valve.
2,527,792 (Standard Oil Co.—Indiana)—Weldable sight glass structure.
2,527,814 (Black, Sivalls & Bryson, Inc.)—Diaphragm motor valve.
2,527,851 (General Controls Co.)—Fluid control valve.
2,527,892 (Sun Oil Co.)—Liquid sealed relief valve for storage tanks.

Fire Extinguishers

2,524,421 (National Foam System Inc.)—Chamber for delivery of foam to sealed tanks containing liquids such as oil or gasoline.
2,525,802 (Specialties Development Corp.)—Liquid carbon dioxide fire extinguishing systems.
2,527,831 (American La France Foamite Corp.)—Foam type fire extinguisher.
2,527,891 (Food Machinery & Chemical Corp.)—Valved nozzle for fire fighting spray guns.

Miscellaneous

2,524,361 (A. O. Smith Corp.)—Induction motor control.
2,524,390 (Hudson Engrg. Corp.)—Fan ring for induced draft cooling towers.
2,524,436 (The Texas Co.)—Clamping device for using radioactive or electronic metal inspection instruments.
2,527,653 (Joseph H. Pierce)—Safety attachment for tank car loading rack.

How to Obtain Patents

Readers may obtain copies of any U. S. patent from the Patent Office at 25 cents each. Order by patent number direct from the Commissioner of Patents, Washington 25, D. C.

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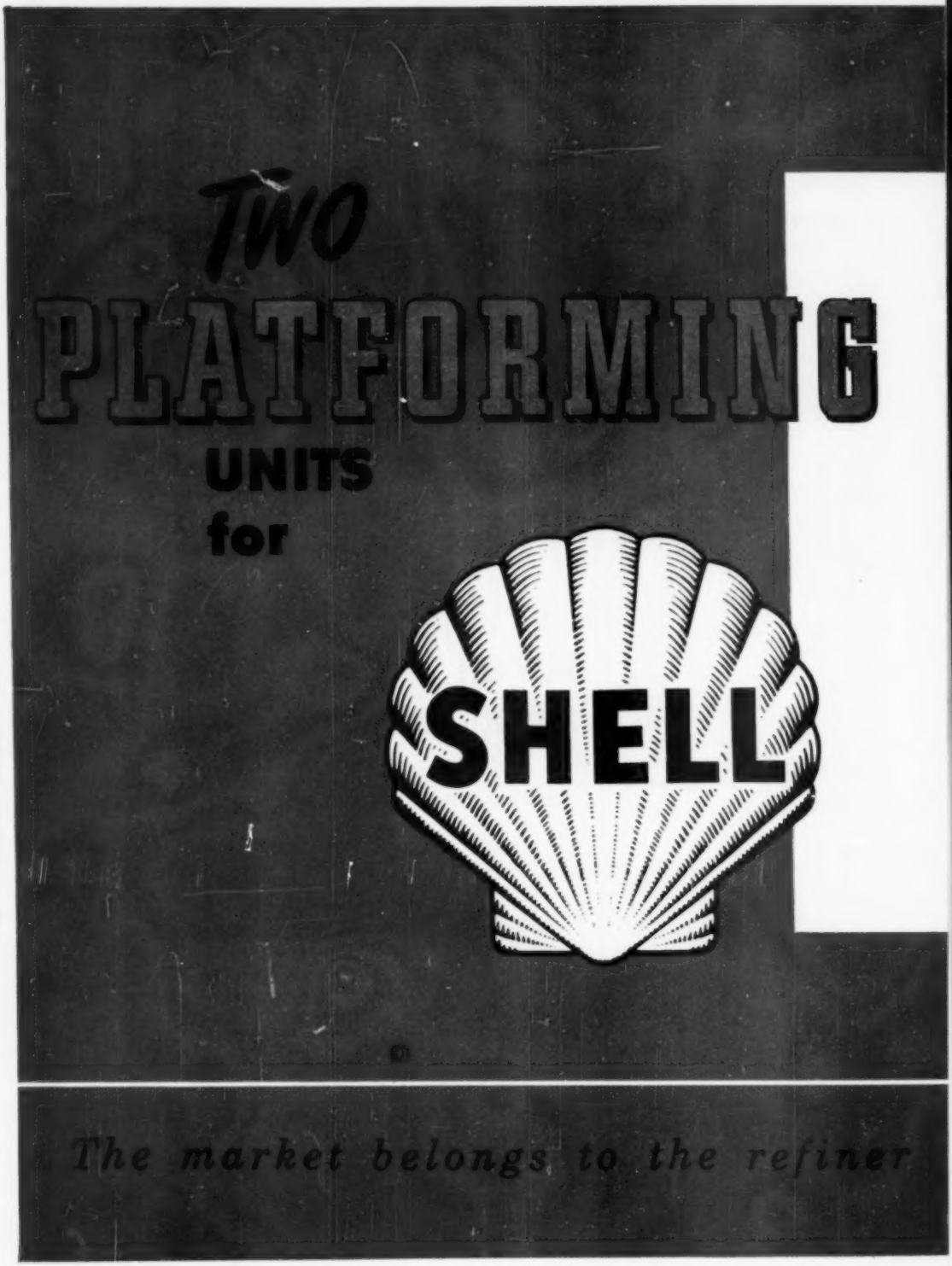
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Houston ISA Show Group Organizes

The Houston Section Committee of the Instrument Society of America met in October to discuss plans for the Sixth National Instrument Conference and Exhibit, to be held at Sam Houston Coliseum, Sept. 10-14, 1951.

The following oil men and instrument men are in this group: Dale Mattix, Cities Service Corp., Lake Charles, La.; M. J. O'Neal, Shell Oil Co., Houston; C. W. Bates and W. H. Fortney; Humble Oil & Refining Co., Baytown; W. B. Rawson, Maintenance Engrg. Corp., Houston; A. Costa, Westcott & Greis, Houston; R. E. Hanson, Leeds & Northrup Co., Houston; E. E. Kleir, Foxboro Co., Houston; R. L. Nichols, Magnolia Petroleum Co., Beaumont; C. L. Garner, Garner Instrument Co., San Antonio; L. C. Books, Shell Oil Co., Houston; I. K. Farley, Brown Instrument Div., Houston.

Ben Weil Joins Ethyl Corporation

Mr. Weil

Ethyl Corp. has named B. H. Weil supervisor of their newly-formed information division at their laboratories in Detroit. Mr. Weil was formerly head of the technical information division, State Engineering Experiment Station, Georgia Institute of Technology. Bernard A. Jones, formerly head of Ethyl laboratories' technical data section, has been named operations manager. Charles B. Kass and Donald MacDonald have been assigned as engineer-writers to the staff. Mr. Kass was previously a technical representative in the technical service division, while Mr. MacDonald was assigned to automotive research operations.

Mr. Weil is a 1939 graduate in chemical engineering of the University of Missouri. He received his master's degree in chemical engineering in 1940 from the University of Wisconsin. Author of many technical articles and several books chiefly in the field of petroleum refining, Mr. Weil edited a "Monthly Summary of Industrial Developments Related to Petroleum Processing," at Georgia Tech's Engineering Experiment Station, and served as editor of "The Filter Prers," a publication of the Georgia section of the American Chemical Society. He is the first editor of "Chemical Literature," new publication of the American Chemical Society's division of Chemical Literature. Mr. Weil has been a contributing editor to PETROLEUM PROCESSING for the past five years.

Fox Moves Up at Graver

Mr. Fox

R. A. Fox, with many years of refinery engineering experience, has been appointed manager of Graver Construction Co., both for American and for all overseas operations. The company's New York, Chicago, and Houston offices, as well as an engineering division Newark, N. J., will be under his direction. He formerly served as field assistant to E. B. Heyden, recently deceased head of the firm.

First employed as an engineer for Winkler Koch Engrg. Co. and then by Sinclair Refining Co. as a designer in Houston, Mr. Fox has been in charge of planning, construction, and operation of several refineries. He was chief engineer for plant enlargement at the Derby Oil Co. in Wichita, Kans., and later construction engineer for new work at Shell Oil Co.'s Wood River, Ill., refinery. For ten years he was chief engineer for Globe Oil & Refining Co., Lemont, Ill. He has served as consulting engineer, both for himself and for Koch Engrg. Co.

Porter Forms Valve Division

H. K. Porter Co., Inc., Pittsburgh, Pa. announced the formation of Jarecki Valves Division, Tulsa, to handle the manufacture and sale of Jarecki Valves formerly produced at Jarecki Manufacturing Co. plant in Erie, Pa.

Established in 1852, the Jarecki Co. manufactured a complete line of iron and bronze valves and cocks. These will now be produced in H. K. Porter's Hinderliter Tool Co. Division plant at Tulsa. Distribution of Jarecki valves is handled through the Jarecki oil field supply stores, the more than 3000 Jarecki jobbers, and direct through the main plant in Tulsa.

Edward Valves to Sell in Europe

Edward Valves, Inc., East Chicago, Ind., has appointed Societe Audco Belge S. A., Brussels, Belgium, as sales representative in continental Europe. Sales contacts will be under the supervision of Fred O. Spitzer of Audco Belge, who will travel Belgium, Denmark, France, Holland, Italy, Luxemburg, and Switzerland.

The Belgian firm is a subsidiary of of Audley Engineering Co. Ltd., Newport, Shropshire, England, which is licensed to make and market Nordstrom lubricated plug valves in the British Isles and on the Continent. Nordstrom is a division, and Edward is a subsidiary, of Rockwell Mfg Co.

Geisler Joins Fisher Scientific

Mr. Geisler

J. William Geisler, formerly with the Bureau of Mines at Bruceton, Penna., where he did research and development on synthetic liquid fuels, has become a member of the Pittsburgh staff of Fisher Scientific Co. as petroleum apparatus engineer. A manufacturer of laboratory equipment and chemicals, Fisher has recently acquired the Tagliabue line of petroleum testing equipment. Mr. Geisler will advise on engineering, manufacture, and distribution of this line, now being distributed under the tradename of "Fisher-Tag."

He has been in the petroleum field over 13 years. Prior to his association with the Mines Bureau, Mr. Geisler was with the Army Ordnance Dept., Gulf Oil Corp., and the Duquesne Light Co. of Pittsburgh.

Catalytic Construction Elects Two

Two new officers have been elected by the board of directors of Catalytic Construction Co. John A. Schumacher was named comptroller, a position formerly held by W. Graham Jamison who was elected vice president and treasurer at an earlier meeting this year. The post of assistant treasurer,

formerly held by Mr. Schumacher, has been filled by F. W. Adams, who in addition to these new duties will continue as manager of the field accounting division.

Tube Turns Names Canadian Manager

Mr. Williams

Wayne E. Williams, with 20 years experience in the petroleum, chemical, and power fields, has been appointed western district manager for Tube Turns of Canada Ltd. His headquarters will be at 110 Clark Bldg., Edmonton, Alberta.

Mr. Williams formerly was associated with C. F. Braun & Co. and the W. M. Barnes Co., Ltd. For the past two years he was project engineer in the erection of a major refinery at Antwerp for the Raffinerie Belge de Petroles. In his new post, he will provide factory information and counsel to designers, erectors, and users of welded piping.

Tonkonogy To Handle Two Lines

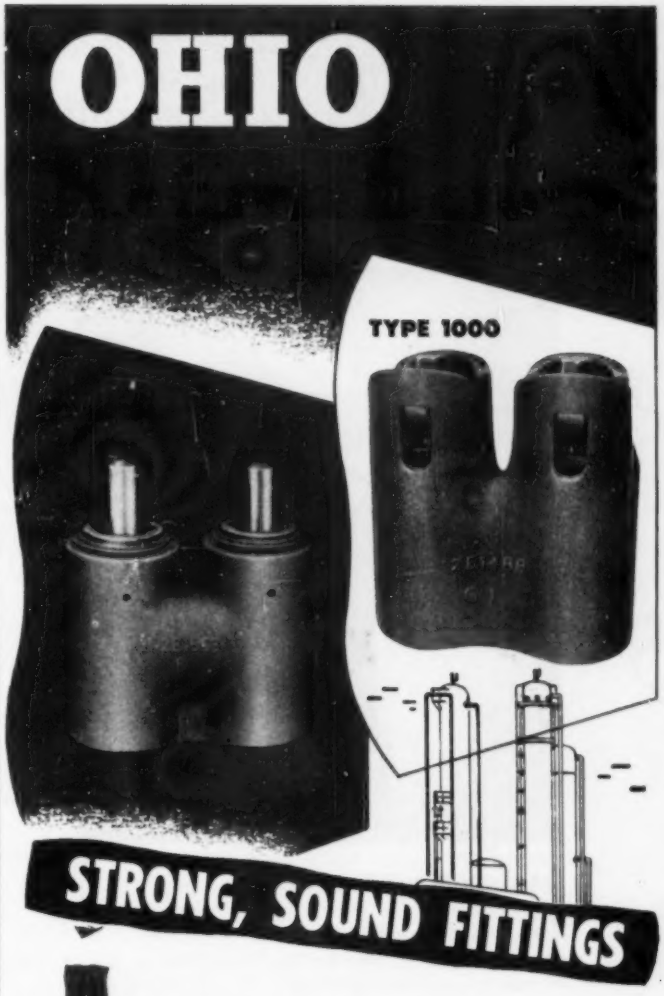
Mr. Tonkonogy

Alwin Tonkonogy of Process Plants Engrg. Co., 45 Clinton St., Newark 2, N. J., has been named to handle two new lines of processing equipment. He has been appointed metropolitan New York district sales representative for Industrial Filter & Pump Mfg. Co., Chicago, for pressure leaf filters, ion-exchange equipment, and rubber lined products.

Mr. Tonkonogy also has been made engineering consultant and sales representative for Manning & Lewis Engrg. Co., Newark, on heat transfer equipment and process vessels, agitators, rotary dryers, and the like.

Panhandle Steel Products Co. — John P. Collier has been named vice-president and sales manager, succeeding Thomas J. Lawless, Jr., and A. B. Phillips is chief engineer, having succeeded J. G. Brown. Other company officials announced are as follows:

R. C. Stanford, vice-president; F. L. Durham, treasurer; Harry L. Nolt, plant auditor and purchasing agent; W. G. Hilley, assistant to the president and C. C. Hughes, plant superintendent.



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News of Suppliers

B-J Los Angeles Manager Named

Mr. Relephord

C. O. Relephord has been appointed to the position of Los Angeles branch manager for the Pump Division, Byron Jackson Co., covering a territory including several western states, Mexico, and the Far East. He was transferred recently from the firm's Houston office, where he was active in the analysis of technical applications of pumps in the oil industry.

A graduate of the University of Oklahoma in 1932 with a B. S. in Petroleum Engineering, Refinery Option, Mr. Relephord served with the U. S. Navy in the Pacific Fleet 1942-46, following which he joined Byron Jackson Co.

Personnel Changes

Celanese Corp. of America — William H. Trotter has been appointed to handle the sales promotion activities of the chemical division. He succeeds Robert D. Burleson, resigned. Mr. Trotter was formerly with Innis, Speiden & Co., the chemistry department of the University of Maryland and the Bureau of Standards.

National Supply Co.—Clarence J. Stubble, with the company 16 years, has been appointed assistant manager of the Eastern division with headquarters in Pittsburgh. J. C. Woods, sales representative at Houston, has been appointed assistant manager of the Eastern division with headquarters at Toledo, Ohio. He joined the company in 1944 at Fort Worth.

Foote Mineral Co.—Dr. Holger G. Anderson, formerly research and development director for Hasting & Co., Philadelphia, and Lawrence J. Reader, formerly senior inorganic research chemist with General Chemical Co. and Wyandotte Chemical Corp., have joined the company's research laboratories at Philadelphia.

Sterling Electrical Motors, Inc.—Alan J. Bronold, with the company since 1926, has been appointed sales manager. He replaces Allen Adams, former head of the company's international and domestic sales organization, who is retiring from active sales management due to illness. Mr. Adams will continue as an officer

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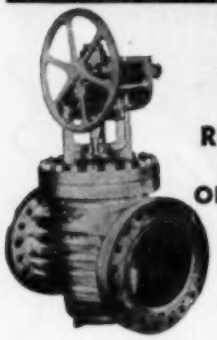

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News of Suppliers

and secretary-treasurer of the company.

Cooper-Bessemer Corp.—John Fulleman, said to be an internationally recognized authority on engine supercharging and centrifugal compressor design, has been working with the company's engineering staff co-ordinating an engine development now under way at the Mt. Vernon, Ohio, headquarters plant.

Freeport Sulphur Co.—Robert C. Hills, Thomas R. Vaughan, and Richard C. Wells have been elected vice presidents, with headquarters at the New York offices.

Pittsburgh Coke & Chemical Co.—E. W. Lawler, sales-service representative, has been transferred from the home offices in Pittsburgh to the Tulsa, Okla., office, where he will assist Manager Frank McNulty in serving the corrosion protection needs of the central West.

Allis-Chalmers—Richard M. Friddle has been assigned to Cleveland and Richard A. Frazee to St. Louis district offices as sales representatives.

Warren Steam Pump Co., Inc.—Edward F. Doty, for many years with Quimby Pump Co. in the design of screw and rotary pumps, has become associated with Warren at its plant in Warren, Mass.

Cochrane Corp.—Ervin J. Bookout has been appointed general sales manager. He was a sales engineer in the company's Philadelphia territory before being promoted to his former position as Eastern sales manager.

Quaker Oats Co. — Charles M. Holmes, assistant manager of the Memphis, Tenn., chemical plant, has been named manager of the new chemical plant to be built in Omaha, Neb., for the production of furfural.

Aldrich Pump Co.—R. H. McPeake has been appointed sales manager, with offices at company headquarters in Allentown, Penna.

Carpenter Steel Co.—William R. Staples, formerly West Coast Representative, has been appointed assistant to the manager of sales, Alloy Tube Division, at Union, N. J. Paul E. Kelly takes over Mr. Staples' Pacific Coast duties.

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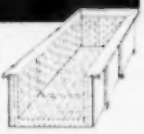

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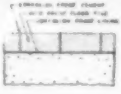

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Crude Oil, Natural Gasoline and Liquefied Petroleum Products

Gasoline and Cycling Plant Operation

Conducted by DAVE THORNTON

Most of the Questions and Answers presented here were transcribed from a wire recording of the popular "Information Please" session of the 29th Annual Convention of the Natural Gasoline Association of America in Fort Worth, April 26, 1950. Publication is made possible through the cooperation of the various authorities participating, NGAA Secretary W. F. Lowe, and the session moderator, J. H. Dunn, Shamrock Oil & Gas Co.

Blending Crude Oil With Natural Gas Liquids

Please discuss some of the problems encountered in blending natural gasoline and butane with crude oil for pipeline movement. What is the maximum vapor pressure normally allowed?

I cannot answer the last portion of that question, although in our own operations we are handling some materials with vapor pressures as high as 40 psi. in crude lines. The limitation strictly is one of pipe line and tankage design, with one exception: care must be used in adding propane to a crude line so that you do not have a beautiful deasphalting plant.

Fortunately, it is possible to test all these combinations in advance of pipelining. Consequently the limitations are (1) what the station equipment is designed to handle and (2) what the tankage available to the line will take before a blend is obtained which will be sufficiently stable to go into ordinary tankage. The latter limitation is a bother only on certain feeder lines ahead of the main-stream operation, where there is sufficient volume of crude to hold down the vapor pressures.

The most modern lines today are built in such a fashion that the stations can handle with equal facility anything from the heaviest crudes to pure propane, for instance. In our own products lines we handle everything from propane to black oils without difficulty. We are limited only by the tankage we have for the volatile products.—S. S. Smith, Shell Oil Co., New York. (NGAA Session.)

Manifolding Safety Valves To Common Exhaust Line

Is it good practice to manifold the exhausts from safety valves to common blowdown lines?

If the safety valves we are talking about handle products volatile enough to give "freezing," certainly they should not be manifolded together. The same applies if they serve a number of plants or units, one of which can fail without the others failing. If the units have safety valves which may be affected by differential pressure they certainly should not be manifolded.

A great deal of thought has been given in the refining business and large pipe line storage terminals on how to get rid of our relief valve spills. Normally we do not have them, but we want them very badly when we do need them. In general, the thesis we have come to accept is that each relief valve should have its own individual line to a torch of some type which can be automatically ignited.—S. S. Smith, Shell Oil Co., New York. (NGAA session.)

Trouble Shooting Methods for Poor Tower Performance

What is the best laboratory method to use in testing natural gasoline plant rectifier performance in order to recognize when changes in column efficiency are due to:

1. **Inadequate reflux**
2. **Overloading with liquid**
3. **Overloading with vapor**
4. **Foaming, entrainment, blowby**
5. **Poor choice of control tray location**
6. **Changes in feed composition and heat content**
7. **Cap design and bubble size.**

What method is used to determine if a column is flooded or nearly flooded?

There is very little to be accomplished by laboratory analyses of column streams in trouble-shooting on a misbehaving fractionator. A.S.T.M. distillation data for top and bottom products will confirm whether or not good separation is being achieved, and the degree and identity of contaminants will be revealed by fractional distillation. I know of no laboratory means for diagnosing the cause of poor separation without also resorting to field investigation of the tower.

The following diagnostic procedure assumes that the tower is an ordinary stabilizer (rectifier) making a controlled quality bottom product. The recommended position for the temperature controller is in the reboiler (at the weir), controlling steam or heating medium into the reboiler. The feed temperature will depend on the temperature control of the preceding column, such as a depropanizer reboiler outlet or heat exchanger performance unless the feed is specially preheated. The overhead product is assumed to consist wholly of butanes and lighter.

With the tower lined out in steady operation, a sample of reflux should boil dry at approximately 32° F. in ordinary altitudes; the laboratory report should show no pentanes and heavier present. If otherwise, the tower is making a sloppy cut, and the same situation exists if propane is found in the bottom product.

Assuming pentanes are present in the reflux, increase the reflux rate materially (10 to 15%) without adjusting any other tower controllers.

Temporarily the tower top temperature will show a corresponding "dip" until the column lines out under the new conditions. If the original reflux rate was insufficient, the "new" top temperature should be materially lower than before, reboiler outlet temperature unchanged, and the end point of the reflux should approach 32° F. The reflux rate then should be adjusted to the optimum value.

If no permanent "dip" is observed in top temperature, the separation will remain sloppy, as evidenced by no reduction in heavy ends. The tower then may be considered overloaded or defective. There are many possible mechanical defects, the most probable being a stoppage somewhere in the tower, missing bubble caps or corroded-out trays.

Overloading from inadequate size generally may be confirmed or eliminated by inspection of the original design data, which will indicate if the column could reasonably be ex-

pected to handle the load being placed on it. The rare exception to this is the case of a load practically equal to fractionator capacity, wherein the safety factor would be nil.

In this case, with ideal feed tray location, feed temperature and constant feed composition, the tower would not be overloaded. A large variation from the ideal feed temperature would overload either reflux condenser or reboiler. Generally a few trays departure from the ideal feed location makes little difference when normal safety factors are used by the designer.

An overloaded reflux condenser is indicated by excessive reflux temperature with cooling water supply at maximum. An overloaded reboiler is detected by inability to reach desired bottom temperature with a wide-open steam supply valve.

With temperature control in the reboiler, plugging or mechanical damage to tower internals usually can be quickly determined by measuring the steam rate to the reboiler at different reflux rates. If the reboiler is not flow-meter equipped, trap condensate may be temporarily diverted to a half-filled barrel of water (to prevent flashing) and the steam rate, indicating heat input, computed. The steam rate should vary in almost direct proportion to the reflux rate.

In the event there is no observed change in the reboiler steam rate, the tower is overloaded or plugged, unless the reboiler temperature varies widely with reflux rate changes. In the latter event, the reboiler is either too small or defective; connections, however, may be inadequate.

Assuming that design inspection has indicated the tower should accept the load, the only way to differentiate between overloading caused by plugging and that resulting from mechanical damage is by recourse to a careful, tray-by-tray inspection of the tower after shut-down. The question of cap design and bubble size is one for research and development, using specialized equipment, and is outside the scope of this discussion.—N. K. Rector, Petroleum Engineer, Inc., Houston.

Employe Aptitude Tests

To what extent have you used employment, intelligence and aptitude tests in choosing better qualified employes for the first time?

We have not used tests of any kind at the time of employment. The reason I have not urged employment tests is because the best test of a man is the actual work he does in his early days of employment. I am not against picking up people and using them for a few days on a temporary job and then transferring them into the plant. But, before this transfer, the man should be adequately considered on the basis of what he will be able to develop into in later years.

The best indication of a man's potentialities is how he takes hold of his work, coupled with a knowledge of his background, experience and education. One of the reasons I am not very strong for employment tests in our own company is because our employment is handled by foremen. The personnel or employe relations department does not attempt in any way to handle the employment problem except that we constantly urge the foremen to get people of the kind we want; those who can develop.

To some extent many people are looking for tests so they can say: "This test shows you can't do the job," instead of saying: "I know you can't do the job, based on the results you have given so far."—M. V. Cousins, United Gas Co., Shreveport. (NGAA Session.)

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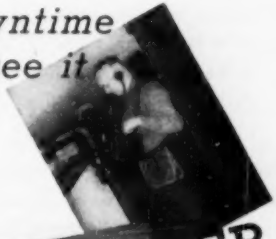

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RAPID — ACCURATE

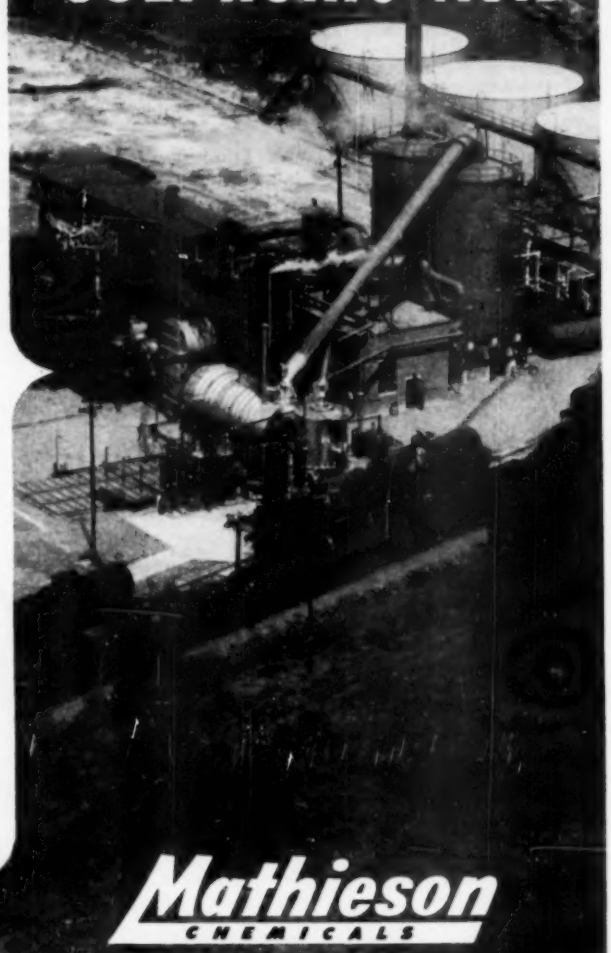
ACCURATE WITHIN 3%
on non-porous materials from 1/16th-inch to 12 inches thick, with flat or curved surfaces; also detects laminar flaws. Effective on glass, most metals, plastics, etc. —

PORTABLE — SELF-POWERED — RUGGED
light and compact; welded-aluminum case, shock-mounted tubes and sturdy components, permit use anywhere in the field "without kid gloves"—

INFORMATION
on the Audigage® *Non-Destructive Thickness Tester*, and on the Branson *Coatingage*, on request.

BRANSON INSTRUMENTS, Inc., Dept. PP264, STAMFORD, CONN.

3 Points that favor using MATHIESON SULPHURIC ACID



1 **UNIFORMLY HIGH PURITY**—Mathieson Sulphuric Acid is clear, colorless and free from such impurities as arsenic, selenium and tellurium because it is made exclusively from pure elemental sulphur in modern equipment.

2 **FULL SELECTION OF GRADES**—Mathieson Sulphuric Acid is available in all commercial grades, ranging from 60° Bé. to oleum, 20%.

3 **BULK SHIPMENTS**—Mathieson Sulphuric Acid is available in tank trucks, tank transports, tank cars and tank barges from Baltimore, Md.; and in tank cars from North Little Rock, Ark.; Shreveport, La.; Beaumont, Port Arthur and Pasadena, Tex.

Mathieson—with its great manufacturing facilities including two of the largest sulphuric acid units in the world—makes not only sulphuric acid but most of the other basic chemicals and many of their derivatives. Be sure to consult Mathieson in planning for your future supply of basic chemicals. Mathieson Chemical Corporation, Mathieson Building, Baltimore 3, Md.

Mathieson CHEMICALS

8514

SERVING INDUSTRY, AGRICULTURE AND PUBLIC HEALTH

REFINING TRENDS

Current Data on Crude Runs, Product Supply and Demand

Crude Runs to Stills of 6,100,000 B/D Forecast for First Quarter of 1951

NOVEMBER refinery operations indicate: Crude runs to stills in December of around 6,100,000 b/d. . . . Continuing high motor fuel demand held gasoline stocks to only a seasonal increase in November. . . . Demand for heating oils (distillate and kerosine) was at a rate that brought a 2,000,000-bbl. decline in stocks. In November, '49, they dropped around 4,750,000 bbls. . . . Sharp gain in residual fuel imports brought November supply to about 15% higher than last year, while rate of demand was about the same.

Crude Runs: Runs to refinery stills currently are about 15% higher than a year ago and they are approaching 6,100,000 b/d avg., which is forecast by the Bureau of Mines for December and also for the average for the first 3 months of 1951. This record rate of over 6,000,000 b/d has been maintained since July. (See Fig. 1) For 10 months of this year crude runs to stills have been 6.5% above a year ago.

Motor Fuel: Indicated motor fuel production in November was at a rate about 9.3% higher than a year ago. (See Fig. 2) However, demand is ahead of a year ago by about the same rate and the indicated gain in gasoline stocks in November of around 4,000,000 bbls. is not unseasonal as compared with the past two years.

Gasoline stocks were increased in November by around 2,000,000 bbls. in the Ind.-Ill.-Ky. territory and by around 1,000,000 bbls. in California and around 500,000 bbls. in Okla.-Kans.-Mo.

The present gasoline stocks total of around 108,000,000 bbls. as of late in November compares with 104,707,000 bbls. on Nov. 30, 1949, and cannot be considered as an excessive inventory in view of present and anticipated demand.

The Bureau of Mines forecast of motor fuel demand for the first quarter of 1951 is 2,622,000 b/d avg., which is 10% higher than the average actual demand of 2,379,000 b/d in the first quarter of 1950. A gasoline yield of 42% is forecast for December, about the same as indicated for November.

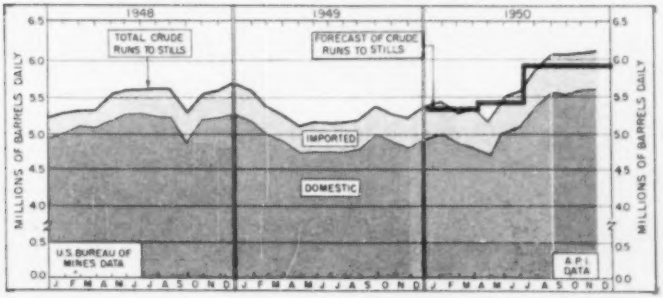
While the volume of natural gas liquids used in motor fuel production is increasing, the proportion used remains the same, around 11%. However, the relative proportion of natural gasoline used in blending is declining consistently, while the proportion of LP-gases, finished gasoline and other natural gas liquids making up the total motor fuel supply is growing.

Heating Oils: The current rate of heating oil production (kerosine and distillates) is over 21% above that of November, 1949. This is being achieved partly through higher crude runs and partly through a yield on distillate close to 20%, as compared with 18% a year ago. Indicated refinery output of distillate in November was nearly 26% higher than in 1949. Indicated demand at refineries for heating oils in November, however, was only around 4% higher than in 1949. The month brought a reduction of around 2,000,000 bbls. in heating oil stocks in November, bringing the total to around 112,000,000 bbls. This figure compares with 113,500,000 bbls. in storage Nov. 30, 1949. In November, 1949, heating oil stocks decreased around 4,700,000 bbls.; in November, 1948, there was a small increase in stocks.

The Mines Bureau's forecast of heating oil demand for the first quarter of 1951 is 2,033,000 b/d, about 9% above the 1,862,000 b/d actual average demand in the first quarter of 1950.

Residual Fuel Oils: A sharp increase in residual fuel oil imports in November brought the indicated current supply to nearly 15% higher than November '49. Refinery production is 4.2% higher than a year ago. Indicated current demand in November was only slightly higher than the year preceding, and there was an indicated gain in stocks of around 1,000,000 bbls. The indicated total as of the latter part of the month of 45,200,000 bbls. compares with 65,112,000 bbls. in storage Nov. 30, 1949, and represents 27 days of forecast demand as compared with 38 days a year ago.

Fig. 1, Runs to Stills 15% Above Last Year



Crude Runs to Stills

Daily Average (1000 bbls.)

	Domestic	Foreign	TOTAL
Nov. '50 API*	5,607	484	6,091
Nov. '49 BM	4,850	442	5,292
Change	+757	+42	+799
% Change	15.6	9.7	15.1

* Through Nov. 25

Total (1000 bbls.)
(Bureau of Mines Data)

10 Mo. '50*	1,575,187	146,459	1,721,646
10 Mo. '49	1,490,474	126,540	1,617,014
Change	+84,713	+19,919	+104,632
% Change	5.7	15.7	6.5

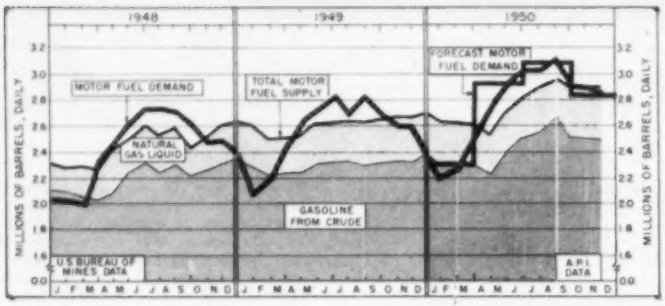
* October from API data.

BM Forecast of Runs to Stills
(1000 b/d avg. Revised Nov. 28)
4th Quar. '50, 6,061; 1st. Quar. '51, 6,100

Yields on Crude Runs to Stills

	Gasoline	Kerosine	Dist. Fuels	Resid. Fuels
	%	%	%	%
Nov. '50 API	41.9	5.6	19.9	20.2
Oct. '50 API	42.1	6.4	19.8	19.8
Sept. '50 BM	42.4	5.8	19.5	19.4
Nov. '49 BM	43.6	5.7	18.0	21.8

Fig 2, Motor Fuel Supply Around 2,900,000 B/D



* Natural Gas Liquids include natural gasoline blended at refineries, and used direct as motor fuel.

Fig. 3, Small Gain in Gasoline Stocks in Nov.

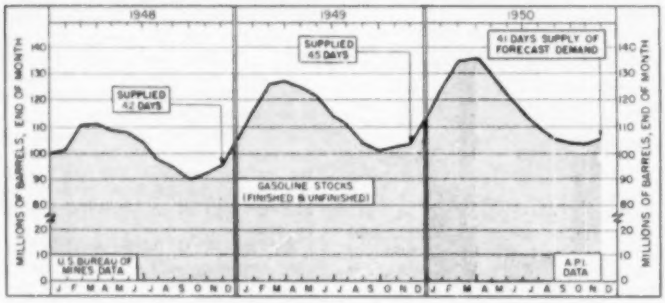

1948
1949
1950
SUPPLIED 42 DAYS
SUPPLIED 45 DAYS
41 DAYS SUPPLY OF FORECAST DEMAND
GASOLINE STOCKS (FINISHED & UNFINISHED)
U.S. BUREAU OF MINES DATA
API DATA
MILLIONS OF BARRELS, END OF MONTH
J F M A M J J A S O N D

Fig. 4, Distillate Output 25% above Nov. '49

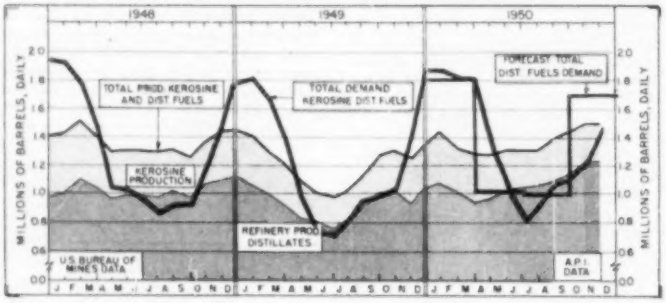
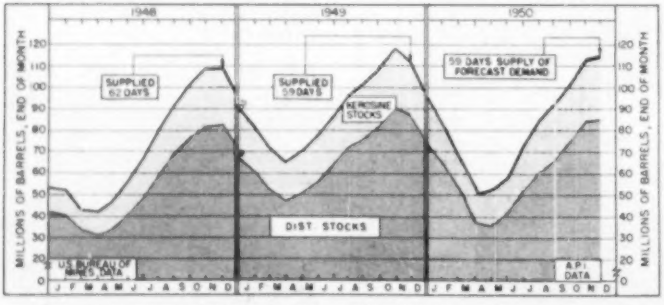


Fig. 5, Drop in Heating Oil Stocks in Late Nov.



* Change in reporting in California eliminated 4,500,000 bbls. from distillate classification.

Motor Fuel Supply

Daily Average (1000 bbls.)

	Gasoline from Crude	Natural Blended Used Direct	TOTAL
Nov. '50 API*	2,550	355	2,905
Nov. '49 BM	2,346	312	2,658
Change	+204	+43	+247
% Change	8.7	13.8	9.3

* Through Nov. 25

Total (1000 bbls.)
(Bureau of Mines Data)

10 Mo. '50*	746,086	99,543	845,629
10 Mo. '49	708,939	89,604	798,543
Change	+37,147	+9,939	+47,086
% Change	5.2	11.1	5.9

* October from API data.

Motor Fuel Demand

Including Exports
Daily Average (1000 bbls.)

Nov. '50 API	2,846
Nov. '49 BM	2,618
Change	+222
% Change	8.5

* Through Nov. 25

Total (1000 bbls.)
(Bureau of Mines Data)

10 Mo. '50*	849,112
10 Mo. '49	796,486
Change	+52,626
% Change	6.6

* October from API data.

BM Forecast of Motor Fuel Demand
(1000 b/d avg. Revised Nov. 28)
4th Quar. '50, 2,802; 1st Quar. '51, 2,622

Gasoline Stocks

Finished and unfinished, end of month (1000 bbls.)

Nov. '50 API*	106,424
Oct. '50 API	104,256
Sept. '50 BM	105,748
Nov. '49 BM	104,707

* On Nov. 25

Heating Oils Production

(Kerosine and Distillates)
Daily Average (1000 bbls.)

	Kero-sine	Dist. Fuels	TOTAL
Nov. '50 API*	330	1,210	1,540
Nov. '49 BM	309	962	1,271
Change	+21	+248	+269
% Change	6.8	25.8	21.2

* Through Nov. 25

Total (1000 bbls.)
(Bureau of Mines Data)

10 Mo. '50*	96,900	320,665	417,565
10 Mo. '49	82,124	278,659	360,783
Change	+14,776	+42,006	+56,782
% Change	17.9	15.1	15.1

*October from API data.

Heating Oils Demand

Daily Average (1000 bbls.)

	Kero-sine	Dist. Fuels	TOTAL
Nov. '50 API*	350	1,150	1,500
Nov. '49 BM	387	1,055	1,442
Change	−37	+95	+58
% Change	9.5	9.0	4.0

* Through Nov. 25

Total (1000 bbls.)
(Bureau of Mines Data)

10 Mo. '50*	89,333	312,948	402,281
10 Mo. '49	78,410	263,282	341,692
Change	+10,923	+49,666	+60,589
% Change	13.9	18.9	17.7

* October from API data.

BM Forecast of Heating Oils Demand
(1000 b/d avg. Revised Nov. 28)
4th Quar. '50, 1674; 1st Quar. '51, 2033

Heating Oil Stocks

(1000 bbls. end of month)

	Kero-sine	Dist. Fuels	TOTAL
Nov. '50 API*	28,291	86,768	115,059
Oct. '50 API	28,844	85,269	114,110
Sept. '50 BM	27,677	78,279	105,947
Nov. '49 BM	25,267	88,212	113,479

* On Nov. 25

Fig. 6, Sharp Increase in Residual Fuel Imports

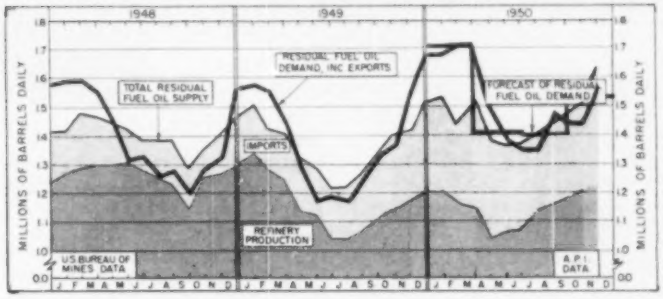
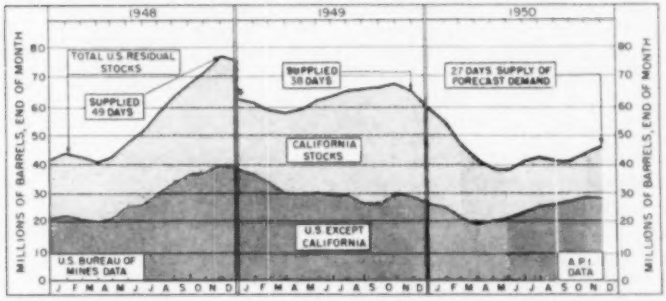

1948
1949
1950
MILLIONS OF BARRELS DAILY
TOTAL RESIDUAL FUEL OIL SUPPLY
RESIDUAL FUEL OIL DEMAND, INC EXPORTS
IMPORTS
REFINERY PRODUCTION
FORECAST OF RESIDUAL FUEL OIL DEMAND
U.S. BUREAU OF MINES DATA
A.P.I. DATA
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

Fig. 7, "Resid" Stocks Low in Terms of Demand


1948
1949
1950
MILLIONS OF BARRELS, END OF MONTH
TOTAL U.S. RESIDUAL STOCKS
SUPPLIED 49 DAYS
SUPPLIED 38 DAYS
27 DAYS SUPPLY OF FORECAST DEMAND
CALIFORNIA STOCKS
U.S. EXCEPT CALIFORNIA
U.S. BUREAU OF MINES DATA
A.P.I. DATA
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

* Change in reporting in California eliminated 13,000,000 bbls. from residual classification.

Residual Fuels Production

Daily Average (1000 bbls.)

	Refinery Output	Imports	TOTAL
Nov. '50 API*	1,250	400	1,650
Nov. '49 BM	1,180	244	1,424
Change	+70	+156	+226
% Change	4.2	65.9	14.5

* Through Nov. 25

Total (1000 bbls.) (Bureau of Mines Data)

10 Mo. '50*	346,136	94,007	440,143
10 Mo. '49	352,135	57,184	409,318
Change	−5,999	+36,823	+30,824
% Change	1.7	64.4	7.5

* October from API data

Residual Fuels Demand

Daily Average (1000 bbls.)

Nov. '50 API*	1,585
Nov. '49 BM	1,553
Change	+32
% Change	2.0

* Through Nov. 25

Total Demand (1000 bbls.)

10 Mo. '50*	531,976
10 Mo. '49	455,608
Change	+76,368
% Change	16.7

* October from API data

BM Forecast of Residual Fuel Demand (1000 b/d avg. Revised Nov. 28)
4th Quar. '50, 1,609; 1st Quar. '51, 1,722

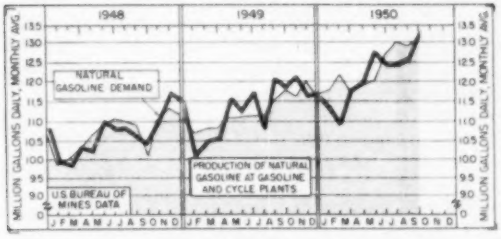
Residual Fuel Stocks

1000 bbls. end of month

	U.S. Except California	Total U.S.
Nov. '50 API*	28,756	45,566
Oct. '50 API	28,985	44,472
Sept. '50 BM	28,342	41,966
Nov. '49 BM	28,593	65,113

* On Nov. 25

Fig. 8, Production and Demand of Natural Gas Liquids


1948
1949
1950
MILLION GALLONS DAILY MONTHLY AVG.
NATURAL GASOLINE DEMAND
PRODUCTION OF NATURAL GASOLINE AT GASOLINE AND CYCLE PLANTS
U.S. BUREAU OF MINES DATA
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

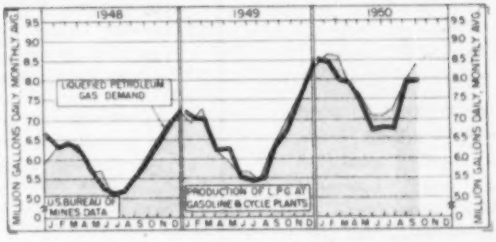
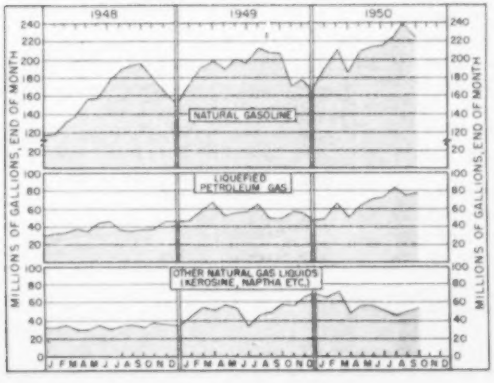

1948
1949
1950
MILLION GALLONS DAILY MONTHLY AVG.
LIQUEFIED PETROLEUM GAS DEMAND
PRODUCTION OF LPG AT GASOLINE & CYCLE PLANTS
U.S. BUREAU OF MINES DATA
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

Fig. 9, Stocks of Natural Gas Liquids


1948
1949
1950
MILLIONS OF GALLONS, END OF MONTH
NATURAL GASOLINE
LIQUEFIED PETROLEUM GAS
OTHER NATURAL GAS LIQUIDS (KEROSINE, NAPTHA ETC.)
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

Natural Gas Liquids Statistics

(Source: U. S. Bureau of Mines Report on Natural Gasoline and Cycle Plant Operations)

	Production (1000 gal./day avg.) Natural Gasoline	LPG**	TOTAL	Demand* (1000 gal./day avg.) Natural Gasoline	LPG	TOTAL
Sept. '50	13,162	8,480	21,642	13,422	8,147	21,569
Sept. '49	11,870	6,680	18,550	11,960	6,680	18,640
Change	+1,292	+1,800	+3,092	+1,462	+1,467	+2,929
% Change	10.9	26.9	16.6	12.2	21.9	15.6
	Total Production (1000 gal.)			**Total Demand (1000 gal.)**		
9 Mo. '50	3,383,188	2,144,096	5,527,292	3,341,678	2,103,275	5,444,953
9 Mo. '49	3,056,297	1,704,527	4,760,824	3,070,871	1,705,014	4,775,885
Change	+326,889	+439,569	+766,458	+270,807	+398,261	+669,068
% Change	10.6	25.8	16.1	8.8	23.4	14.0

Stocks, End of Month (1000 gal.)

	By Type of Product: Natural Gasoline	LPG	Other Products†	By Location: Refineries	Gasoline Plants	TOTAL
Sept. '50	224,917	79,399	56,074	112,392	247,998	360,390
Aug. '50	236,563	76,365	51,087	115,248	248,767	364,015
Sept. '49	207,187	54,258	58,070	105,000	214,515	319,515

* Demand, including exports but not transfers, is supplied from receipts from outside sources as well as current production and stock changes at gasoline plants. Outside receipts in September totaled 5,693,000 gals.

** Does not include LPG produced at refineries which in August totaled 96,516,000 gals.

† Includes naphtha, kerosine, specialty and other products.

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Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products or services which interest him. This code letter appears in parentheses to the left of the advertiser's name.

●

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Fill in your name, title, company and mailing address and mail the card. . .no postage is required.

The Petroleum Processing Reader Service Department will give your inquiries prompt and efficient handling.

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(D) ALUMINUM CO. OF AMERICA.. 1280

(E) ALUMINUM CO. OF AMERICA.. 1332

(F) AMERICAN CYANAMID CO...1256, 1257

(G) ATLAS MINERAL PRODUCTS CO. 1348

(H) ATTAPULGUS CLAY CO. 1292

(I) BADGER & SONS CO., E. B...1294, 1295

(J) BETHLEHEM STEEL CO. 1362

(K) BETZ, W. H. & L. D. 1361

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(P) CHICAGO BRIDGE & IRON CO. .. 1282

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(R) CRANE CO., THE 1274

(S) CRANE PACKING CO. 1359

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(U) EASTERN INDUSTRIES, INC. .. 1369

(V) ETHYL CORP. 1253

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(X) FOSTER WHEELER CORP. ..... Facing 1292, 1293

(Y) FOXBORO COMPANY, THE 1271

(Z) FRANKLIN SUPPLY CO. 1275

(AA) GENERAL AMERICAN TRANSPORTATION CORP. 1254

(AB) GENERAL AMERICAN TRANSPORTATION CORP. 1371

(A) GENERAL CHEMICAL DIV., BAKER & ADAMSON PRODUCTS, ALLIED CHEMICAL & DYE CORP. ..... Inside Back Cover

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(AD) GLOBE STEEL TUBES CO. 1288

(AE) GRAVER WATER CONDITIONING CO. 1296

(AF) GRISCOM-RUSSELL CO. ..1286, 1287

(AG) HARTZELL PROPELLER FAN CO. 1289

(AH) HOUDRY PROCESS CORP. 1258

(AI) HUDSON ENGINEERING CORP. ..... Inside Front Cover

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(AL) LUMMUS CO. 1278, 1279

(AM) MATHIESON CHEMICAL CORP. 1352

(AN) METAL TEXTILE CORP. 1340

(AO) MONSANTO CHEMICAL CO. .. 1265

(AP) MCKEE & CO., ARTHUR G. 1358

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(AW) OIL WELL SUPPLY CO., UNITED STATES STEEL CORP.. 1268

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(AY) PENBERTHY INJECTOR CO. .. 1270

(AZ) PETRO-CHEM DEVELOPMENT CO., INC. 1267

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(BB) PETROLEUM RECTIFYING CO. 1365

(BC) PHILLIPS PETROLEUM CO. .. 1277

(BD) POWELL CO., THE WILLIAM.. 1281

(BE) PRECISION SCIENTIFIC CO. .. 1346

(BF) PRITCHARD & CO., J. F. 1333

(BG) PRITCHARD & CO., J. F. 1369

(BH) ℅ PROPORTIONEERS ℅ 1261

(BI) REFINERY ENGINEERING CO... 1262

(BJ) RIDGE TOOL CO., THE 1366

(BK) ROCKWELL, W. S. CO. 1335

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(B) SOLVAY SALES DIV., ALLIED CHEMICAL & DYE CORP. .. 1337

(BN) SUN SHIPBUILDING & DRY-DOCK CO. 1290

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(AW) UNITED STATES STEEL CORP., OIL WELL SUPPLY CO. 1268

(BP) UNIVERSAL OIL PRODUCTS CO. 1342, 1343

(BQ) UNIVERSAL OIL PRODUCTS CO. 1367

(BR) WARREN PETROLEUM CORP... 1349

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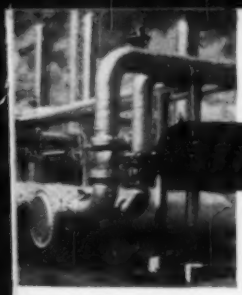
(BV) WYATT METAL & BOILER WORKS ..... Outside Back Cover

(BW) YARNALL-WARING CO. 1370



WHAT'S NEW!

Equipment
Materials
Processes
Literature

Reviewed by WILLIAM C. UHL, Equipment Editor

Induction Period Calculator Reduces Errors in Oxidation Stability Testing

An "Induction Period Calculator" is being offered by Precision Scientific Co. to eliminate human error in interpretation in the ASTM test for oxidation stability of gasoline, D-525. Tested for eight years in the duPont Laboratories where it was developed, the device has proved successful in providing a fast, accurate, reproducible means of calculating the induction period in gasoline oxidation stability tests. For a complete description and instructions for use of the Calculator see Petroleum Processing. Sept., 1948, pp. 848-850, "Use Induction Period Calculator for Oxidation Stability Tests," by E. L. Korb, director, Petroleum Chemicals Laboratory, E. I. du Pont de Nemours & Co., Wilmington, Del. The device comprises two parts: a durable white laminated plastic disc, 15 inches in diameter, and a heavy bakelite template. The template fits over a brass hub to aid in centering pressure recorder charts. Either Taylor or Foxboro charts can be used. Calibrations on the disc are printed below the top film of plastic and will not rub off with wear. Precision Scientific Co.

Circle No. **1** *on Reply Card*

For More Information

Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which ycu are interested. Then fill in the rest of the card and drop it in the mail. No postage required.

New High Strength Steel Conserves Costly, Strategic Alloying Materials

The first of a new group of alloy steels to be known as "T-steels," has been announced. "Carilloy" T1 is a multiple-alloy plate steel combining extremely high strength with excellent ductility and toughness, even at subzero temperatures. It is expected to effect savings in applications calling for heavy steel members of ½-in. thickness and up. Costly and strategic alloying materials have been conserved in the design of this new alloy, it is stated. Its strength is drawn from small quantities of a comparatively large number of alloying elements that are readily available. It is furnished heat treated to a minimum yield strength of 100,000 psi. Welding does not affect the properties of Carilloy T1 adversely. No special treatments are required beyond those normally used with ordinary structural steels. If low-hydrogen type electrodes are used, it is not susceptible to under-bead cracking. Bending or forming can be accomplished cold if sufficient power is available. Hot forming must be followed by proper heat treatment. Carbon content of the metal is restricted to 0.18 max. to promote ease of welding and gas cutting. United States Steel Corp.

Circle No. **2** *on Reply Card*

High Sensitivity, Mass Range to 400 Offered in New Mass Spectrometer

The new Consolidated Analytical Mass Spectrometer, Model 21-103, is said to provide ten times the sensitivity previously available and a mass range up to 400. A new ion source

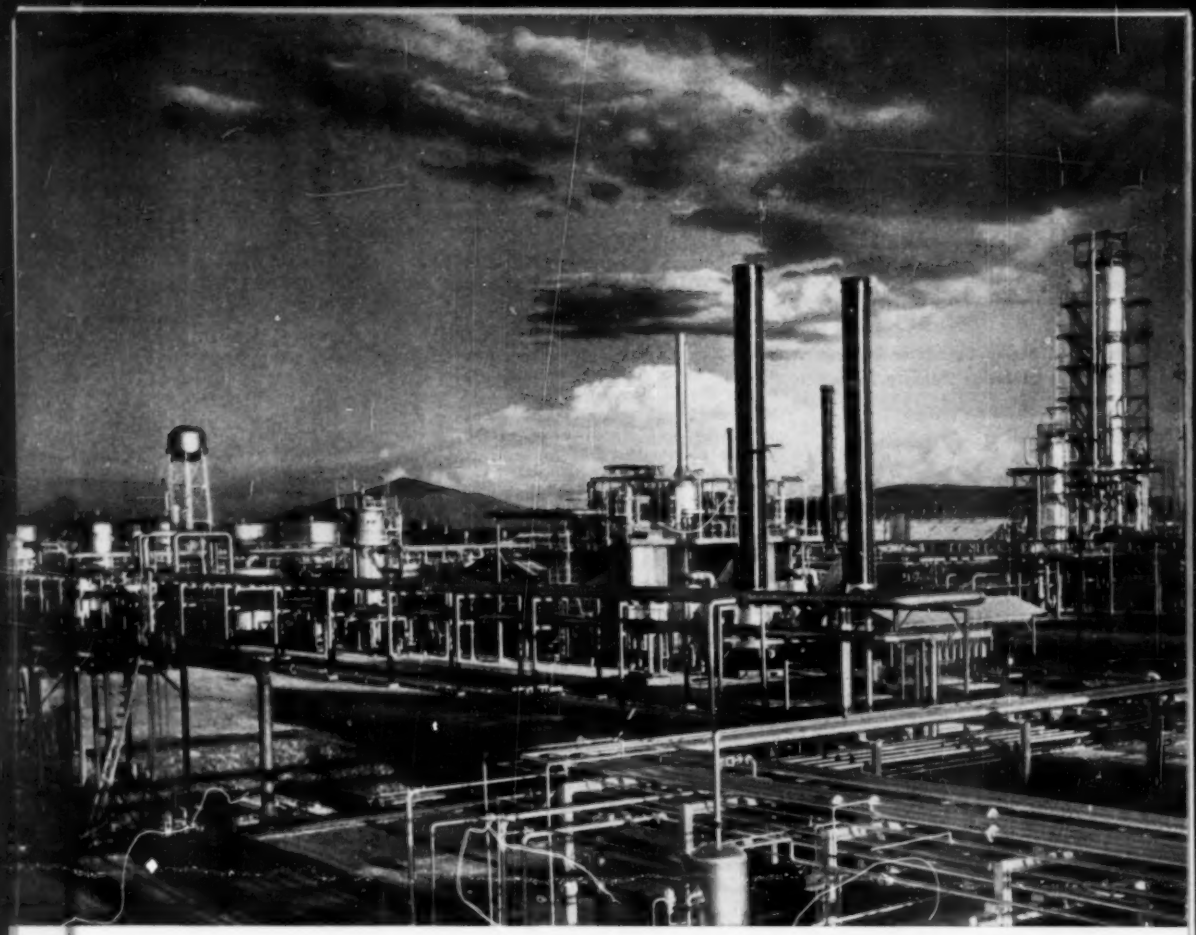
(the "Isatron") and a Stainless steel analyzer replace the previous ionization chambers, analyzer tube, and glass envelope, to provide the more efficient ion optical system. The resolving power, in addition, can be adjusted during operation. Another feature permits the suppression of the metastable ions when desired. The Isatron is easily demountable from the analyzer and its filament can be quickly replaced. A new sample introduction system is featured also. Its main body is machined from Stainless steel and incorporates metal valves as an integral part. Direct measurements of sample pressures are made with a new electronic micromanometer. The same oscillograph recording system has been retained as is used with the Model 21-102. Consolidated Engrg. Corp.

Circle No. **3** *on Reply Card*

Small Air Hammer Uses No Trigger, Starts by Being Pressed into Work

A new light-weight pneumatic hammer for scaling, riveting, chipping, and many general applications features a unique no-trigger construction. The hammer operates when pressed into contact with the work, stops when it is withdrawn. The "Appton Super Hammer" is small in size, measuring 9½ inches overall, and has a 1-inch diameter piston. It weighs about five lbs. and will operate on pressures from 30 to 100 psi. in accordance with the work requirements. Force of blow can be controlled, from a light tap for delicate jobs, to full power for heavy applications. Burgess Thomas Co.

Circle No. **4** *on Reply Card*



New 30,000 Barrel Pemex Refinery at Salamanca

Engineered and Constructed by Arthur G. McKee & Company

LOCATED in an important industrial and agricultural area of the high plateau region of Mexico, this refinery is one of the most beautiful ever built. Sound, thorough engineering is clearly evident in its well-planned, clean-lined arrangement and efficient construction.

The complete refinery is comprised of processing units for Crude Distillation, Thermal Cracking and Catalytic Desulfurization and units for gasoline and kerosene treating and ethyl blending. Power plant, steam plant, water supply system, tankage and extensive shop and maintenance facilities are provided.

With a 30,000-barrel-per-day capacity, this new refinery is designed to produce gasoline, kerosene, diesel oil, other gas oils, liquefied petroleum gas and residual fuel oil.

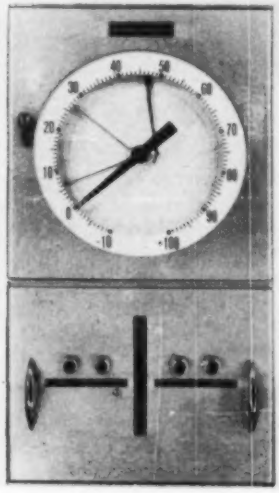
ARTHUR G. McKEE & COMPANY

DESIGN, ENGINEERING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES

ENGINEERS AND CONTRACTORS • ESTABLISHED 1905
2300 CHESTER AVENUE, CLEVELAND
30 Rockefeller Plaza, New York, N. Y.

Filament Temperature, not Resistance Is Basis of Combustible Gas Alarm

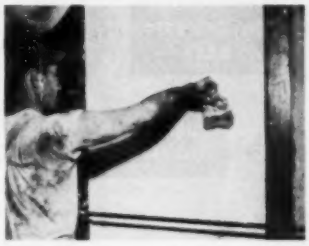
A continuous combustible gas alarm system incorporates a new, more accurate principle of gas and vapor analysis and measurement, achieved by use of a filament construction employing fine platinum wire and a thermocouple. Actual increase in temperature of the wire is measured rather than its increased resistance, as with the older Wheatstone bridge principle. Zero drift has been virtually eliminated, it is said. The new system has been placed in operation by Shell Oil Co. to protect a new products pipeline automatic pumping station. An additional feature cited for the new device is that the drawing of the sample is monitored so that immediate warning is given of clogged filters or flashback arrestors. Davis Instruments Div., Davis Emergency Equipment Co.



Circle No. 5 on Reply Card

Canvas Cover for Furnaces, Boilers Provides Substitute for Scarce Steel

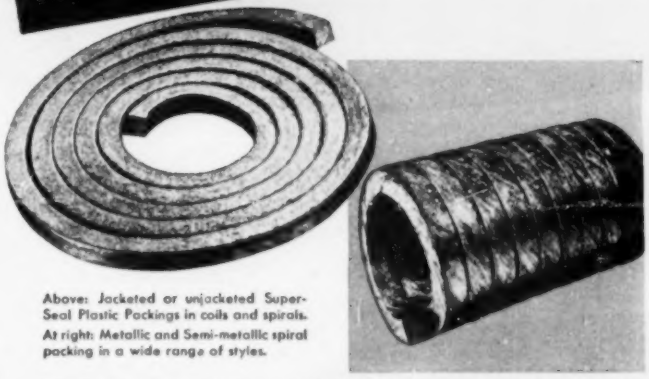
"Texad," a new canvas covering for boilers or other industrial furnaces, is being offered as a substitute for expensive and hard-to-get steel plate normally used as an outside covering over insulation cement. In addition, it is said to improve air tightness, reduce enclosure costs, and provide a weatherproof finish for outdoor installations. Texad combines



a plasticized synthetic resin emulsion, used as an adhesive, with strips of light-weight canvas. The covering seals the unavoidable shrinkage cracks in the finish coat of insulating cement and guards against air leakage caused by the insulation's own porosity. The Texad finish is applied like wallpaper, with no bolting or welding required. It dries to a bright, white finish and can be washed down when desired. Or it can be painted with aluminum or colored paint if preferred. Bigelow-Liptak Corp.

Circle No. 6 on Reply Card

Here's a "JOHN CRANE" tip on a new packing value!



Above: Jacketed or unjacketed Super-Seal Plastic Packings in coils and spirals.
At right: Metallic and Semi-metallic spiral packing in a wide range of styles.

TODAY Metallic and Plastic Packings cost no more than Fabric styles

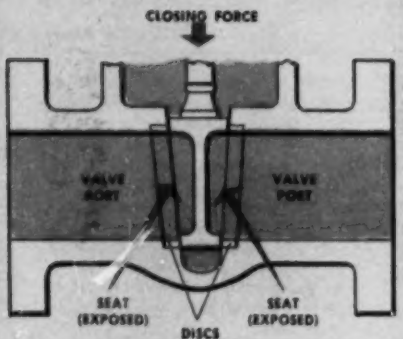
There never was a better time for you to switch over to more efficient metallic and plastic packings. We make fabric styles, too, but we want you to know that, at today's prices, metallic and plastic give you more for your money.

For example, graphite lubricant is vulcanized right into Super-Seal Plastic packings...which means they can't dry out like lubricated asbestos packings...and they last longer, with less gland adjustment. Metallic packings are practically frictionless on such equipment as centrifugal pumps . . . a feature resulting in longer packing life and significant power savings.

You owe it to yourself to see how this new cost picture can produce better results for you. If you are not familiar with our metallic and plastic styles, you'll want our literature.
Dept. P-11, 1832 Cuyler Ave., Chicago 13, Ill.

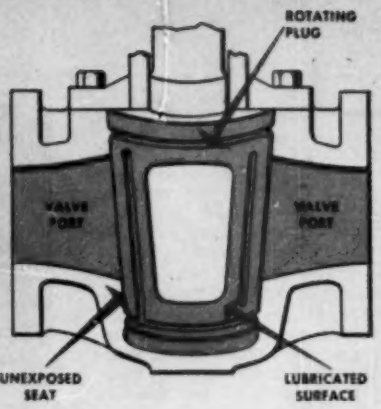
JOHN CRANE
PACKINGS AND MECHANICAL SEALS
CRANE PACKING COMPANY
CHICAGO
Offices in All Principal Cities in United States and Canada

[To obtain more data on advertised products see page 1356]



UNLUBRICATED GATE

LUBRICATED NORDSTROM



lubrication

There are only two ways to get a seal between two metal surfaces within a valve:

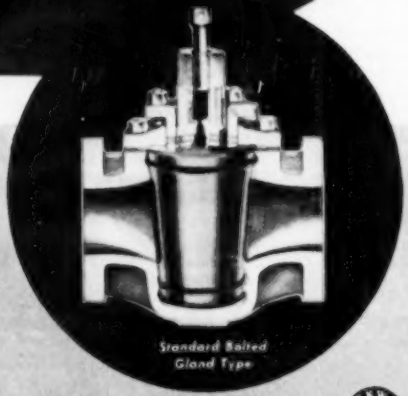
1. Force the seating surfaces together by distortion, which often involves excessive stresses and galling.

2. Use a plastic sealing medium between the surfaces.

Leakage and cutting is certain to occur where valve seats are exposed because line fluid carries abrasive elements that wear down the surface or eventually cut it.

But by using a plastic lubricant seal on the *unexposed* tapered seat of the Nordstrom valve, abrasion is avoided.

So when you install Nordstroms you stop abrasion. You then have valves that will last years longer; remain free from leakage, and turn easily. Never is it necessary to hammer-blow a Nordstrom. Lubricant hydraulically applied keeps the valve in perfect functional condition.



Nordstrom

NOW AUTOMATICALLY LUBRICATED WITH

Valves

Trade Mark Hypermatic Pats. Applied for

ROCKWELL MANUFACTURING COMPANY

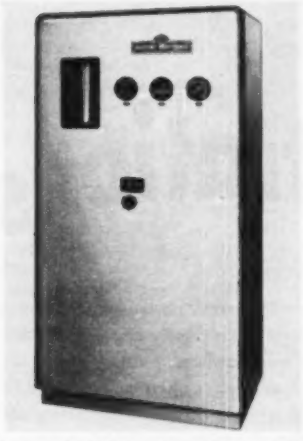
400 North Lexington Avenue • Pittsburgh 8, Pennsylvania

Atlanta, Boston, Chicago, Columbus, Houston, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco, Seattle, Tulsa . . . and leading Supply Houses. Export: International Division, Rockwell Manufacturing Company, 7701 Empire State Bldg., New York 1, N.Y.

ASTM Accepts Metal Thermometer As Alternate to Mercury-Glass Type

A new adaptation of the Model 2221 Weston all-metal thermometer has been accepted by the ASTM as an alternate to mercury-glass, angle stem thermometers, according to the manufacturer. Developed to overcome the breakage problem encountered with glass instruments, the new instruments are designed to fit the sockets already incorporated in many pressurized tanks used in the petroleum industry. The new thermometer covers a range from 0 to 150° F., with the scale marked in 1° divisions. Accuracy is within 1° over the entire scale. Dial is 5 inches in diameter; stem is 3 ft. long, with the measuring element in the first 2 inches. Construction is said to be fume-proof, moisture-proof, and corrosion-resistant throughout. Weston Electrical Instrument Corp.

Circle No. **7** *on Reply Card*



Automatic Chlorination at Three Points Features New Chemical Feed Control

Automatic control of chlorine flow to three points of application and a visible gas flow indicator are cited as features of the new "HCVS high Capacity Chlorinizer" announced and introduced at the National Power Show last month. The automatic control will provide the proper feed rate to meet the chlorine demand at three individual locations and also will select the sequence of point of application. This insures proper metering and control of chlorine dosage for any predetermined period at a suitable pre-selected rate of flow. The instrument is recommended for use in the control of slimes in cooling water systems, in chemical processing, and for industrial waste treatment. Builders-Providence, Inc.

Circle No. **8** *on Reply Card*

Trade Literature

Future of Grease Research

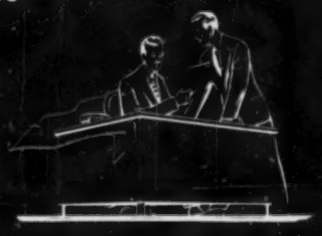
Lubrication, Dec., 1950, Vol. 36, No. 12, consists of an eight-page article entitled "New Horizons of Grease Research," discussing the continuing trend toward real technology in the "art" of grease manufacture and formulation. The Texas Co.

Circle No. **9** *on Reply Card*

Automatic Control Instrumentation

Ratio Totalizer, Bulletin No. 5450, presents 12 suggested applications in automatic control circuits for this instrument, a pneumatically-operated device for accurately combining input control pressures and spring forces to produce a single output pres-

How to Select a Cooling Water Service



First, look for a service based on sound engineering practice—one that is experienced in the solution of individual cooling water problems.

Second, look for a service which has a proven record of eliminating corrosion, scale, and biological fouling—at a cost that is not excessive.

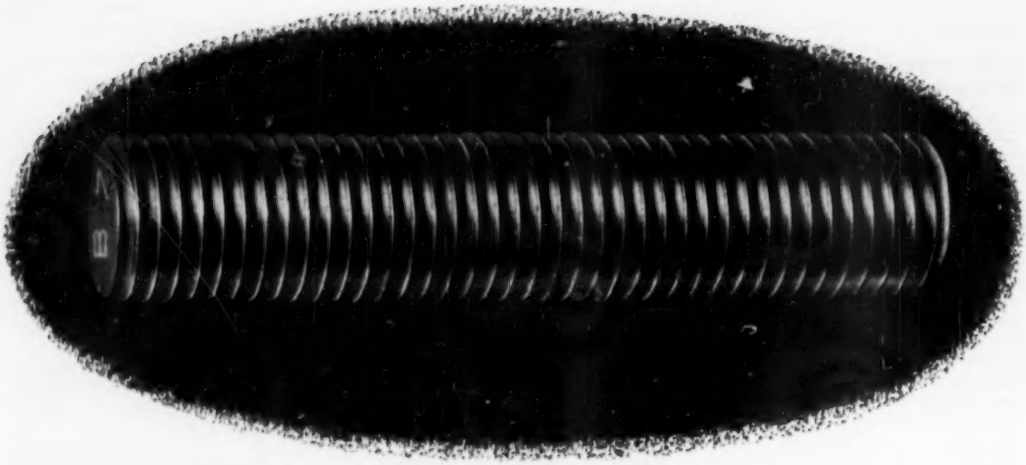
Finally, look for a service which is backed by an organization with ample facilities to extend prompt assistance when and if special problems or emergencies arise.

For over two decades BETZ has provided engineering guidance and developed control procedures for the correction and prevention of industrial water difficulties. If the results you are presently obtaining are not fully satisfactory, our nationwide staff of engineers welcome the opportunity to discuss your water problems. W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa.

BETZ

COOLING WATER CONDITIONING · BOILER WATER CONDITIONING

[*To obtain more data on advertised products see page* 1356]



Minimizes Stress concentrations

Regardless of the high temperatures and high pressures encountered in refinery bolting jobs, you can be sure of reliable performance when you use the Bethlehem Continuous-Thread Stud.

This is because the Bethlehem Continuous-Thread Stud does such an effective job of minimizing stress concentrations. The stud has no point of thread runout. Consequently, when stresses do occur, they can't concentrate at any one point — instead they are effectively distributed over the entire working length of the stud.

The Bethlehem Continuous-Thread Stud is made from carbon or alloy steels, and comes either plain or heat-treated. It is furnished in a wide range of diameters and in any length, with most sizes carried in stock.

We'll be glad to answer your questions about the use and economy of the Bethlehem Continuous-Thread Stud. Put them up to the nearest Bethlehem sales office, or get in touch with us at Bethlehem, Pa.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

Bethlehem supplies every type of Fastener

sure, useful in computing circuits for addition, subtraction, multiplication and division, averaging, and in control action for proportional band, with automatic reset, rate action, or combinations. Hagan Corp.

Circle No. **10** *on Reply Card*

Hose for Refinery Uses

Rubber Products for the Petroleum Industry, an 18-page, pocket-size catalog includes the following products for possible refinery use: air, steam, and fire hose (including neoprene), fire hose coupling and nozzles, oil suction and discharge hose; as well as a general line designed for marketing and distribution. Carlyle Rubber Co., Inc.

Circle No. **11** *on Reply Card*

Processing Pumps

Yeomans Pumps, Manual 2300, describes a full line of pumps for handling corrosive and non-corrosive liquids, solids-carrying liquids, and dry and semi-dry materials, in both horizontal and vertical centrifugal types. Yeomans Brothers Co.

Circle No. **12** *on Reply Card*

Water and Waste Treatment

Cochrane-Liquon Sludge Contact Reactors, Publication 5001; a 16-page bulletin explaining the operation of this type of equipment, covering round and rectangular styles, suggested applications, auxiliary equipment, chemical feed methods. Cochrane Corp.

Circle No. **13** *on Reply Card*

Electro-chemical Measurements

Fundamentals of Industrial Electrochemical Measurements and Automatic Control; Technical Bulletin No. B51-2; 24 pages covering the basic chemical concepts in such measurements as pH, oxidation-reduction potential (redox), electrolytic conductivity, and the final control elements in automatic systems employing these types of measurement. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

Circle No. **14** *on Reply Card*

Fire-Proofing Cement

Eagle-Picher Fire-Proofing Cement, an eight-page brochure describing how the material can be used to protect structural metal members from collapse during fires; including tables indicating the light weight of the coating as compared to other methods, results of fire test, etc. Eagle-Picher Sales Co.

Circle No. **15** *on Reply Card*

Centrifugal Purifier Manual

Centrifix Engineering Manual; eight pages of tables and formulas for selecting the correct centrifugal purifier sizes for entrainment problems involving internal applications in drum, evaporator, receiver and also line units for branches; with formulas to calculate volume, actual flow, velocity, pressure drop, etc. The Centrifix Corp.

Circle No. **16** *on Reply Card*

Right Angle Drive for Vertical Pumps

Peerless "Gearturbo" Pump Head, Bulletin B-140-1; covers construction features with sectional drawings and dimensions, engineering data and specifications on a right angle geared

He'll steal your Plants!
Btu's are "Shop-Lifters" if given half a chance. When they wander from the straight and narrow, they push operating costs sky-high, drive efficiency and employee morale way down . . . and walk off with much of your profit. Keep Btu's in line by protecting your equipment with CAREY Industrial Insulation. When you do, Btu's will work like beavers — you'll save fuel, increase efficiency, too!
CAREY Makes The Complete Line
85% Magnesia—Industrial Rock Wool
Asbestos—Pipe Coverings—Sheets—
Blocks—Batts—Papers—Air-Cell
Write for your free copy of "Heat Insulation For Industry." Address your request to Dept. PP12, The Philip Carey Manufacturing Company, Cincinnati 15, Ohio. In Canada: The Philip Carey Company, Ltd., 1557 MacKay Street, Montreal 25, P.Q.
Call your Carey representative today. He's a trained expert who is eager to serve you.
And to keep Btu's on the job at high temperatures—here's a new, improved insulation
Carey Tempchek
a specialized material with a temperature range up to 1500° F., low K-factor, rugged strength, excellent Handleability—
It's a combination of outstanding qualities
Ask about it!
Carey

[*To obtain more data on advertised products see page* 1356]

drive for vertical turbine pumps, useful where electricity is not available or economical; in wide range of gear ratios and hp. ratings from 3 to 300. Peerless Pump Div., Food Machinery & Chemical Corp.

Circle No. **17** *on Reply Card*

Industrial Tool Control

McCaskey Tool Crib Control, Bulletin A-510 REV; presents a step-by-step procedure to prevent theft, hoarding, and loss of tools loaned to employes; cut crib inventories, eliminate delays from missing tools; reduce breakage and otherwise speed service and cut costs. McCaskey Industrial Controls.

Circle No. **18** *on Reply Card*

Automatic Instrumentation

Taylor Technology, Autumn 1950, Vol. 3, No. 2; contains a six-page article on "Characteristics of Automatic Control Responses," and another shorter article on a high capacity positioner which provides fast action on large valves. Taylor Instrument Cos.

Circle No. **19** *on Reply Card*

Controlled Odorization

IN NATURAL GAS DISTRIBUTION

with the New Consolidated

TITRILOG

CONSOLIDATED TITRILOG
Model 26-102

Accurate control of the odorization of natural gas is a major problem facing many gas distribution companies today. The importance of odorizing gas to a known and fixed level, in order to assure its safe and economical distribution, is ever increasing with the rapid expansion of natural gas utilization.

The Consolidated Titrilog is now being used in production plants and on distribution lines to continuously record the concentration of the odorant in the stream. Thus, a constant odor level in the gas is insured and a permanent record is acquired for legal evidence of effective odorization.

The Titrilog quantitatively records sulfur compounds such as H_2S, SO_2, mercaptans, thioethers, thiophene, and organic disulfides in concentrations as low as 0.1 ppm or 0.005 grains per 100 cubic feet. Compounds of specific interest may be separately determined over a wide range of concentrations.

For complete information on the Consolidated Titrilog and other applications, such as problems in corrosion, sour-gas treating, etc., write for Bulletin CEC-1810-X17.

SPECIFICATIONS

Sensitivity The Titrilog quantitatively records oxidizable sulfur compounds in concentrations as low as one part in ten million or 0.005 grains per 100 cubic feet.

Power Requirements The Titrilog operates on standard 60-cycle 115-volt power. It requires approximately 6 amperes.

Cabinet Dimensions The Model 26-102 Titrilog is housed in a floor-mounted cabinet 66-inches high, 22½-inches wide, and 18½-inches deep. The strip-chart recording milliammeter is mounted at eye level, and directly below it is the control panel.

CEC

CONSOLIDATED ENGINEERING CORPORATION

Analytical Instruments for Science and Industry

620 NO. LAKE AVE. PASADENA 4, CALIFORNIA

Steam Trap Bulletin

Super-Silvertop Steam Traps, Bulletin No. 550, contains specifications, capacities, sizes, pressures, weights, and list prices on all principal types in a line of inverted bucket type traps; including data on self-cleaning strainers and other products. V. D. Anderson Co.

Circle No. **20** *on Reply Card*

Kel-F Dispersions Data

Kellogg Technical Bulletin 4-10-50 contains information on the properties and methods of applying "Kel-F" (trifluorochloroethylene thermoplastic) dispersions — brushing, dipping, or fusion techniques—in the protection against corrosion of valve interiors, and similar equipment. M. W. Kellogg Co.

Circle No. **21** *on Reply Card*

Mechanical Draft Fans

Green Mechanical Draft Fans, Bulletin No. 168; 20-page booklet describing a line of fans for both forced and induced draft service, with drawings of typical styles, charts on performance curves, details of construction, drive arrangements, and mounting methods. Green Fuel Economizer Co., Inc.

Circle No. **22** *on Reply Card*

Anti-Oxidation Additive

Anti-Oxidant 2246, Cyanamid New Product Buletin No. 16; 13 pages of technical data on a chemical product — 2,2'-methylenebis (4-methyl-6-tertbutylphenol)—an oxidation inhibitor for rubbers, paraffin waxes, gasolines, and other petroleum products. (Note: This bulletin was reviewed in "What's New!" for November, page 1244, Item 20; and the product "2246" was incorrectly described as a sodium polyacrylate.) American Cyanamid Co.

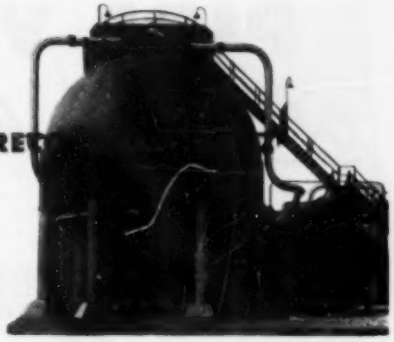
Circle No. **23** *on Reply Card*

Instrument Catalog

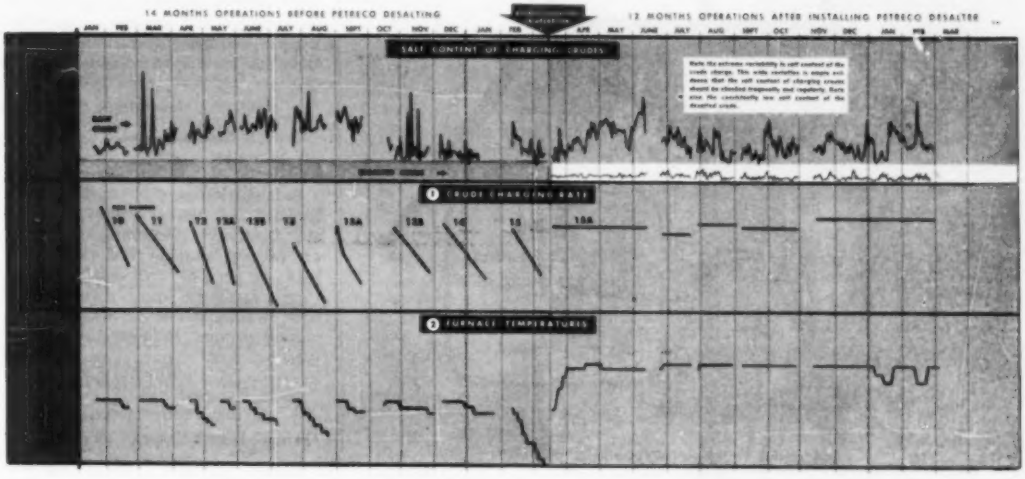
Wheelco Condensed Catalog-Instrumentality, Bulletin Z6600; describes in brief form a line of recorders, controller, indicators, combusition safeguards, and control accessories; including an up-to-date four-page price list. Wheelco Instruments Co.

Circle No. **24** *on Reply Card*

OVER TWO YEARS OF RECORDED REFINING OPERATIONS PROVIDE GRAPHIC PROOF OF BENEFITS FROM PETRE



For a 26 month period, 14 months *before* the Petreco Desalter was installed, and 12 months *after* the desalter was in operation, refinery personnel at a Texas refinery carefully observed and graphed the effects of salt on the operations of one unit. Particular attention was paid to the salt content of the charging crude and to the charging rates and furnace temperatures, both before and after installing the Petreco Desalter.


14 MONTHS OPERATIONS BEFORE PETRECO DESALTING
12 MONTHS OPERATIONS AFTER INSTALLING PETRECO DESALTER
JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB APR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR
SALT CONTENT OF CHARGING CRUDES
1 CRUDE CHARGING RATE
2 FURNACE TEMPERATURES

The top graph shows the wide variation in salt content before desalting with Petreco, and to what low values Petreco reduced the salt in the crude charge.

Graph No. 1 shows how the comparatively high salt content of the crude caused the daily charging rate to decline. The effect of Petreco Desalting is obvious in the right hand section.

Graph No. 2 illustrates how Petreco Desalting permitted the use of higher *sustained* furnace temperatures. Before desalting, even the lower temperatures employed dropped off rapidly.

Petreco desalting does not necessarily benefit every refiner in exactly the same way, since refineries differ widely in charging procedures, flow schemes, and so on. However, regardless of the physical characteristics of the crude charged, the flow scheme of the refinery, or the type of refining procedures used, with every installation, Petreco Desalting has shown a rapid pay-out in improved operations, increased capacities and substantial maintenance economies.

Profit by the experience of the many refiners who rely on Petreco for the more economical operations assured by efficient salt removal. For further information, write or call

PETROLEUM RECTIFYING COMPANY

5121 SO. WAYSIDE DRIVE, HOUSTON 1, TEXAS
1390 E. BURNETT ST., LONG BEACH, CALIFORNIA

ONLY PETRECO OFFERS COMPLETE DESALTING SERVICE PERSONNEL AND FACILITIES

PETRECO

SPECIALIZED *Electric* PETROLEUM PROCESSES { DESALTING / DEHYDRATING

PIPE VISE

plus . . . a handy work bench

RIDGID Tristand's tray keeps all your tools in easy reach

● No stooping, less fatigue and speedier work now that you don't have to bend over every time you change tools. New tray attaches in a jiffy, makes Tristand rigid so it can't fold up in use. Legs have rubber feet to prevent creeping. RIDGID's LonGrip tool-steel jaws won't slip, won't mar polished pipe and tubing. Yoke vise, 2½" capacity; chain vise, 4." Buy new work-saver RIDGID Tristands from your Supply House.

RIDGID

WORK-SAVER PIPE TOOLS

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Circle No. 25 *on Reply Card*

Tube Rolling Controller

John Crane Tube Rolling Control, eight pages describing a new control instrument for automatic operation of tube rollers and expanders, covering design features, operating instructions, calibration, etc. Crane Packing Co.

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Diesel Engine Bulletin

Baldwin Series 600 Diesel Engine, Bulletin 321; covers design features, specifications, performance curves, and ratings (ranging from 430 to 1500 hp.) on engines with speed ranges from 360 to 625 rpm., with 12¾-in. bore, 15½-in. stroke, for stationary or marine service. Baldwin Locomotive Works.

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"Teflon" Seated Valves

Aloyco "Teflon" Seated Valves, Technical Information Bulletin No. 5; four pages describing line of Teflon-seated and packed valves, including a 3000 psi. working pressure needle valve in sizes ¼ to 1-in.; a 600 psi. W. P. plug gate valve, ⅛ to ½-in.; and two sampling valves for 150 and 300 psi. service. Alloy Steel Products Co., Inc.

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For Your Convenience

Business reply cards are included in each issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing the first page of this section. Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the bottom of the card and drop it in the mail. No postage required.

LPG as Tractor and Automotive Fuel Is Subject of SAE Meeting Symposium

A SYMPOSIUM on "Liquefied Petroleum Gas as Tractor and Automotive Fuel" will highlight the annual Society of Automotive Engineers meeting in Detroit next month —at least as far as petroleum industry members are concerned.

The symposium will be held on the afternoon of Monday, Jan. 8—the opening day of the five-day meeting. It is being sponsored by SAE's Tractor and Farm Machinery Activity group, and is under the chairmanship of W. H. Worthington.

Papers scheduled for the symposium include the following:

"Liquefied Petroleum Gas for Motor Fuel—Future Supplies and Distribution," by R. C. Alden and F. E. Selim, Phillips Petroleum Co.

"Engine and Carburetion Equipment Requirements for Liquefied Petroleum Gas Fuel," by A. J. St. George, Ensign Carburetor Co.

"Comparative Operating Data of Tractors Using Gasoline or Liquefied Petroleum Gas Fuel," M. J. Samuelson, Minneapolis-Moline Co.

The SAE Fuels and Lubricants Activity has two technical sessions scheduled, both on Tuesday, Jan. 9.

The morning session includes the presentation of the Horning Memorial Award to Daniel P. Barnard, research coordinator for Standard Oil Co. (Ind.), who will present the Horning Memorial Lecture—"The Role of Fuel in Engine Development."

A second paper on the morning session will be "Trends in Motor Fuel Volatility," by W. M. Holaday and D. P. Heath, Socony-Vacuum Oil Co.

Two papers are scheduled for the afternoon session:

"A New Look at Motor Gasoline Quality—Carburetor Icing Tendency," by J. F. Kunc, Jr., J. P. Haworth, and J. E. Hickok, Esso Laboratories, Standard Oil Development Co.

"Series 2 Oils Pay Their Way," by W. G. Brown and F. E. Kronenberg, Caterpillar Tractor Co., and J. A. Edgar and F. A. M. Buck, Shell Oil Co.

Other Papers of Interest

"Combustion Characteristics of Diesel Fuels as Measured in a Constant Volume Bomb," by R. W. Hurn and K. J. Hughes, U. S. Bureau of Mines (Diesel Engine Activity session, Monday, Jan. 8).

"Low-Temperature Starting and Operation of Diesel Engines," by A. W. Sloan, A. C. Scurlock and D. P. Herron, Atlantic Research Corp. (Diesel Engine Activity session, Monday, Jan. 8).

"Current Status of Automotive Diesel Engine Design and Performance in Great Britain," by C. B. Dicksee, A. E. C. Ltd. (Diesel Engine Activity session, Monday, Jan. 8).

"Low Temperature Lubrication of Aircraft Engines," by Saul Barron, Powerplant Laboratory, Air Materiel Command (Aircraft Powerplant Activity session, Wednesday, Jan. 10).

MEETINGS . . . for the Oil Man

DECEMBER

28-29, American Chemical Society, Div. of Industrial and Engineering Chemistry, Christmas Symposium, Baltimore, Md.

JANUARY, 1951

8-12, Society of Automotive Engineers, Annual Meeting and Engineering Display, Book-Cadillac Hotel, Detroit.

15-18, Second Plant Maintenance Conference and Show, Public Auditorium, Cleveland.

19, American Chemical Society, New York Section, Symposium of Radioisotopes, Hotel Statler, New York.

FEBRUARY

23, Natural Gasoline Association of America, Regional Meeting, Settles Hotel, Big Spring Texas.

MARCH

5-7, Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, William Penn Hotel, Pittsburgh.

5-9, American Society for Testing Materials, Spring Meeting and Committee Week, Cincinnati, Ohio.

11-14, American Institute of Chemical Engineers, Regional Meeting, The Greenbrier, White Sulphur Springs, W. Va.

12-16, First South American Oil Congress, Montivideo, Uruguay.

13-16, National Association of Corrosion Engineers, Annual Conference and Exhibition, Hotel Statler, New York.

APRIL

1-5, American Chemical Society, 119th National Meeting (divided), Boston, Mass.

2-4, Western Petroleum Refiners Assn., 39th Annual Meeting, Plaza Hotel, San Antonio, Texas.

8-12, American Chemical Society, 119th National Meeting (divided), Cleveland, Ohio.

16-18, American Society of Lubricating Engineers, National Convention, Bellevue-Stratford Hotel, Philadelphia.

30-May 3, American Petroleum Institute, Division of Refining, Midyear Meeting, Mayo Hotel, Tulsa.

30-May 4, 4th National Materials Handling Exposition, International Amphitheatre, Chicago.

2nd Plant Maintenance Show

Forty-five speakers from a cross-section of industry will address the 2nd Plant Maintenance Show and Conference when it gets under way in Cleveland's Public Auditorium, Jan. 15-18. In addition, 150 companies will display thousands of products designed to cut maintenance costs.

General sessions will be held on Preventive Maintenance, Organization and Management for Maintenance, Applied Lubrication in Industry, and Housekeeping. In addition, separate conference meetings will be devoted to lighting equipment, problems of the small plant, electrical equipment, and power plant and heating equipment.

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PERSONALS

Walter C. Teagle, formerly of Standard Oil Co. (N. J.) and one of the founders of American Petroleum Institute, has been given the 1950 Gold Medal Distinguished Achievement award by the API. Although retired from the oil industry, he is active as head of the Teagle Foundation, an organization he established to aid young people in obtaining higher education.

Mr. Teagle

Following his graduation from Cornell University in 1899, he began working for his father, John Teagle, head of the Scofield, Shurmer and Teagle oil firm which subsequently was absorbed into the Republic Oil Co. In 1903 he joined the export committee of Standard Oil. The next few years took him through Europe and South Africa, and he became head of the export department, a member of the board of directors for Standard Oil, and in 1911, a vice president.

In 1914 he became president of Imperial Oil Co. of Canada and he organized the International Petroleum Co., Ltd., a producing company in Peru. He was elected president of Standard of New Jersey in 1917. He directed the organization of the Standard Oil Development Co., the financing of the Humble Oil and Refining Co., and the joining with General Motors in creating the Ethyl Corp. In 1937, Mr. Teagle became chairman of the board and turned the presidency over to **W. S. Farish.**

* * *

Dr. Cecil E. Boord, professor at Ohio State University, has been invited to address the Third World Petroleum Congress at The Hague this spring to present an account of the hydrocarbon research program which he has directed at Ohio State for the past 12 years.

Dr. Boord first came to the University in 1907 as a fellow in chemistry, with a background of work in knock-suppressing and knock-inducing substances in gasoline and individual hydrocarbons, and the development of a method of pure hydrocarbon synthesis. He became a permanent member of the faculty in 1909 and is the first and only director of the Hydrocarbon Research Project. Sponsored by the API and maintained by contributions from 70 member corporations, the work is officially known as "a project for the synthesis, purification and the study of the properties of hydrocarbons of low molecular weight." The program is aimed at producing synthetically each of the many hydrocarbon components of gasoline and testing these compounds on internal combustion engines.

* * *

Milton S. Beringer has been appointed to the board of directors of the British American Oil Co. Ltd., He is vice-president in charge of manufacturing.

Since joining B-A in 1934 as a refinery superintendent, Mr. Beringer has built several major refineries, including those at Moose Jaw, Calgary and Clarkson. He directed the recently completed expansion at Montreal East Refinery; under his direction a new plant is being built at Edmonton and the existing refinery at Moose Jaw is being expanded.

In his early years in the petroleum industry, Mr. Beringer was engaged in refinery operations for several U.S. companies and also worked as supervising engineer on two refinery construction projects at Ploesti, Roumania.

Mr. Beringer has been superintendent of B-A's Turner Valley absorption plant and Calgary refinery. He was appointed manager of refineries in 1945 and later the same year assumed his present position of vice president in charge of manufacturing.

* * *

Max B. Anfenger, Standard Oil Co. (Calif.), **Emil J. Senne,** Socony-Vacuum Oil Co., Inc., and **Clyde W. Smith,** Standard Oil Co. (Ind.), have been awarded "Certificates of Appreciation" for service in the field of safety by the American Petroleum Institute. These men were specifically cited as follows:

Mr. Anfenger, retired, for persistent efforts and valuable accomplishments in the development of new and improved fire-protection techniques, and in the protection of the industry against unreasonably restrictive regulations.

Mr. Senne, retired, for outstanding services rendered in the organization of the Institute's accident prevention department and committees.

Mr. Smith, retired, for 14 years of

Colleagues Congratulate Boyer on New Position

Marion W. Boyer, who has resigned from Esso Standard Oil Co. after 23 years to become general manager with the U. S. Atomic Energy Commission, receives the congratulations of colleagues at a party given in his honor on November 3. He was presented a silver punch bowl set by his many friends in the Jersey Standard companies. (See PETROLEUM PROCESSING, Nov., p. 1248)

Shown left to right are: H. G. Burks, Jr., executive vice-president of Esso; William Naden, Esso vice-president; Mr. Boyer and M. J. Rathbone, Standard Oil Company (N. J.) director.

consistent and vauable aid in the establishment and development of the Institute's safety services.

Mr. Anfenger was presented witn his certificate during the API's 30th annual meeting in Los Angeles, November 13-16. Mr. Senne and Mr. Smith received their certificates during the National Safety Congress in Chicago this month.

* * *

Howard Cooper, manager of technical service for the Sinclair Refining Co., has been elected president of the National Lubricating Grease Institute during the organization's annual meeting in Chicago. A member of the NLGI's board of directors since 1945, he served as vice-president last year. **G. E. Merkle,** vice-president of Fiske Brothers Refining Co., has been elected vice-president this year and **C. B. Karns,** Esso Standard Oil Co., has been re-elected treasurer.

* * *

L. C. Dawson has been appointed head of the paraffin and lubricating section, petroleum technical service department, of Esso Standard Oil Co., Baton Rouge, La. **F. D. Richards** has been promoted to fill Mr. Dawson's former position as head of the phenol extraction and lube quality group of this department. **C. D. Singer** has been named head of the utilities and light ends section.

* * *

Carl O. Peterson has been appointed safety engineer at the Bayonne, N. J., refinery of Tide Water Associated Oil Co. Working in conjunction with the plant protection and mechanical departments he will be in charge of the general administration of safety activities in the refinery.

Prior to joining Tide Water, Mr. Peterson worked as a safety engineer for General Motors Corp. and Babcock and Wilcox. He also had safety experience with the Combustion Engineering Corp. He has attended Rutgers University and holds a certificate from the American Red Cross with a credit of over 400 hours of first aid instruction.

* * *

Julian Alexander, Jr., formerly assistant to the director of the API Division of Refining, has left that position to study for the Presbyterian ministry.

* * *

G. W. Hart has been transferred to Vernon, Calif., as superintendent of measurement for General Petroleum Corp. He was formerly superintendent at the Lebec, Calif., refinery.

* * *

Harold L. Lawler has been transferred to the Slaughter gasoline plant of Stanolind Oil & Gas Co. near Sundown, Texas. He was formerly an operating engineer at the company's Elk Basin gasoline plant, Elk

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Basin, Wyo. Mr. Lawler received his B.S. degree in chemical engineering from the University of California in June, 1941.

* * *

George W. Watts, director of engineering for the manufacturing department of Standard Oil Company (Ind.), has been elected a fellow of the American Society of Mechanical Engineers for "acknowledged engineering attainments."

After graduation as a mechanical engineer from the University of Illinois in 1915, Mr. Watts joined Standard as a draftsman at its Whiting, Ind., refinery. In 1928 he became chief engineer for the manufacturing department, and was instrumental in the formation of the engineering research department in 1945.

During World War II Mr. Watts was on leave of absence to direct for Kellex corporation the design, construction, procurement, and erection of pumping equipment and process instrumentation for the Oak Ridge, Tenn., uranium diffusion plant.

* * *

W. L. Pursell, El Dorado, Kansas, has been promoted to chief engineer at Skelly Oil Co.'s refinery there. He has been with Skelly 13 years, starting as a chemist in the research and development department, then transferring to refinery operation. He is a graduate of Oklahoma A & M College.

* * *

Dr. Bernard H. Shoemaker, divisional director of research of the Standard Oil Co. (Ind.), has been elected chairman of the American Chemical Society's division of petroleum chemistry. **Dr. F. E. Frey,** assistant director of research of the Phillips Petroleum Co., was named chairman-elect, and **Dr. C. G. Kirkbride,** vice-president of the Houdry Process Corp., was re-elected secretary-treasurer.

W. A. Pardee, chemical engineer for Gulf Research and Development Co., has been elected chairman of the ACS's division of industrial and engineering chemistry. **Miroslav W. Tamele,** associate director of research for Shell Development Co., will assume duties as 1951 chairman of the division of colloid chemistry.

* * *

Harry J. Burns has been appointed senior resident engineer in Mexico for the Perco Division of Phillips Petroleum Co. In this position, Burns will represent Perco licensing and engineering services in the various refineries of Petroleos Mexicanos.

Mr. Burns

Burns received his degree from St. Mary's College, St. Marys, Kansas, in 1931. He joined the refining department of Phillips in 1932, and progressed to superintendent of manufacturing at the Phillips Kansas City, Kansas refinery. In September 1945, Burns transferred to Mexico City as Phillips operation supervisor under the Phillips petroleum supervisory contract with the Mexican Government.

* * *

P. K. Kuhne, assistant to the general manager, Gulf Oil Corp.'s manufacturing department, has been given the added assignment of assisting in the administration of the technical division, manufacturing department.

Mr. Kuhne received a B.S. degree in chemistry from Tulane University in 1927. He joined Gulf as an assistant chemist in the Port Arthur refinery in 1927 and subsequently became chief chemist at the Philadelphia refinery in 1930, and supervisor of the refinery technology division there in 1934.

Mr. Kuhne was transferred to the company's general offices in Pittsburgh as assistant to the general manager, manufacturing department, in 1941 and will continue there.

He served on numerous PAW Committees during the war and was a member of the Technical Oil Mission to Germany.

* * *

J. R. White has been appointed executive vice president of Imperial Oil, Ltd.

A graduate of the University of Toronto, Mr. White joined Imperial in 1933 and worked at Sarnia as a draughtsman and engineer. In 1937 he came to the U. S. and a year later joined Standard Oil of Venezuela. He became a vice president of that company in 1942. Returning to Imperial in 1944, he soon was made a director and a vice president.

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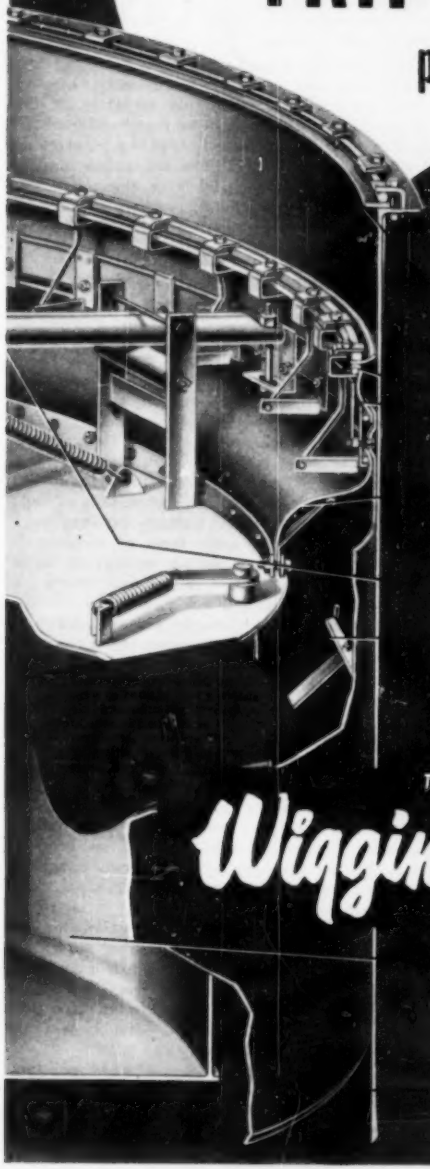

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EDITORIAL VIEWPOINTS

Opinions and Comments on Current Topics

Hitching Onto the War Program

THE Bureau of Mines, always watchful for a means to extend its present experiments in producing synthetic liquid fuels into the field of commercial operations, has proposed that coal hydrogenation plants of 30,000 b/d capacity be built for the primary purpose of producing benzene. The alternative method to secure greater supplies of benzene, to alleviate the present shortage of this important wartime chemical, it is recognized, would be to produce it synthetically from refinery hydrocarbons. Two oil company benzene units are now in operation, in Texas and in California.

Present production of benzene from all sources is around 180,000,000 gallons annually, of which less than 10,000,000 gallons is a synthetic product, the remainder coming from coal coking. The indicated shortage for 1951 is said to be 30,000,000 gallons, which will have to come from other sources than the coal tar plants.

The yield of benzene from a 30,000 b/d project is estimated by Bureau of Mines officials at around 34,000,000 gallons annually, and the cost of two 15,000 b/d coal hydrogenation plants is put at $300,000,000. The plants would have to be built from the ground up, taking around 3 years before they could start operating. More important still, such plants would require enormous amounts of steel, between 125,000 to 135,000 tons, by the Bureau's earlier estimates of materials required for commercial coal hydrogenation operations.

A quicker and surer program to increase benzene supplies will be to produce it from petroleum. While the amount of benzene occurring naturally in crudes in the U.S. is less than 0.1% by volume, the Bureau of Mines should immediately analyze the crudes of the country, and others available to refiners here, to determine what crudes carry the largest naturally occurring percentages of benzene and also what will supply the most suitable intermediate hydrocarbons for synthetic benzene production. These oils would supply suitable feed stocks.

The facilities required for producing benzene synthetically from petroleum are practically the same as those used in World War II for making synthetic toluene. With this experience, and that available from the two refineries now producing synthetic benzene, the additional required supplies of this chemical can be secured more promptly than from coal hydrogenation projects. Also at less cost in steel and other materials, since the source of production would be process units of already functioning petroleum refineries.

Plant Protection Work Lags

LESS than a dozen companies were represented at a special and informal meeting held during the recent API meeting in Los Angeles to consider the wartime protection needs of refining and other facilities. However, a start was made there toward organizing a program that will aid the companies in setting up their own plant security programs to combat sabotage, subversive efforts, and actual attack, in the event war comes. J. Howard Myers, Atlantic Refining Co., Philadelphia, was named chairman of the committee and D. V. Stroop of the API Headquarters staff secretary.

Setting up effective plant protection today against various forms of enemy efforts is in the same category as installing adequate fire protection measures. If the system is any good at all it has to be ready and working at the moment needed. The refinery security program as proposed can only succeed if it has the active support and participation of management from the top down. Country-wide cooperation in the API program would be evidence of such support.

There Is No Suppression of Patents

THE title of Bill H.R. 9304, introduced in Congress by Representative Clemente, of New York, is a wilful distortion both of fact and purpose. The measure is entitled "A bill to prevent the suppression of patents", which is a false premise, and the purpose actually is to bring about the compulsory licensing of patents. The Department of Justice is understood to have fathered the present bill.

Critics of our patent system frequently bring up the charge that patents are secured for the purpose of suppressing inventions. If such were actually the case there might be some ground for some form of compulsory licensing. However, various patent authorities have brought out that there is not a single case on record of the suppression of a patent, nor have the extensive hearings on patent matters brought out an authentic case. Critics fail to distinguish between the non-use of a patent and its suppression. From the practical angle, if there is a profit to be made from a patented device, the owner will try to get it or someone else will obtain a license from him for that purpose.

On the other side of the matter, great harm could result from the compulsory licensing of patents, which would be in effect taking away private property in the form of rights of an inventor to the profits from his invention. H.R. 9304 provides that, where the inventor or licensee after 5 years has failed to make, use or vend his invention, the Commissioner of Patents may order the invention made available to the public on terms and conditions he himself would prescribe.

This would greatly interfere with the incentive for the patent owner to invest in the development of his invention, and would make it difficult for firms and individuals to secure outside financing for this purpose. Economics or other practical factors determine when an invention can actually be put into use, which is often more than 5 years distant from the issuance of the patent.

The passage into law of H.R. 9304 would be a prime means for emasculating a patent system which has been in successful use for 150 years, and has been the source of the technical and industrial developments that have made us a great nation.

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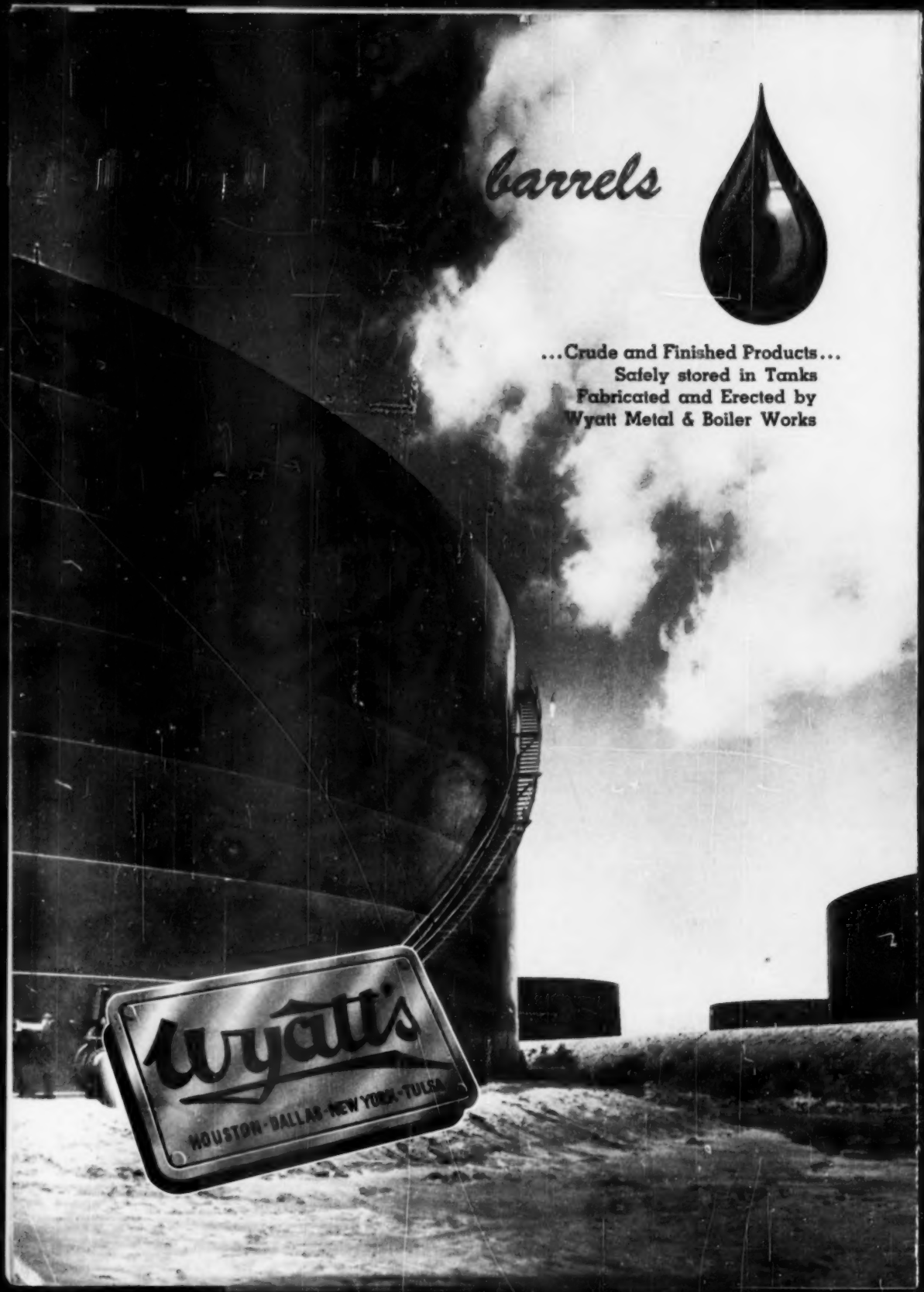
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